THE GAS JOURNAL

MARCH 21, 1934

Vol. 205. 86th Year No. 3696

A Glance at the Contents—

Post Vacant.

Applications are invited for the position of Secretary to a Gas Company in Yorkshire. [p. 771.]

Watford and St. Albans Company's Centenary.

The Watford and St. Albans Gas Company are at the present time celebrating their 100th anniversary, and an interesting centenary brochure has been compiled. [p. 738.]

Principles of Gas Lamp Design.

This was the subject of a paper by Mr. L. T. Minchin, B.Sc., of the Gas Light and Coke Company, before the London and Southern District Junior Gas Association. [p. 754.]

National Gas Council.

A Meeting of the Central Executive Board of the National Gas Council was held at 28, Grosvenor Gardens, S.W. 1, on March 13—Sir David Milne-Watson, LL.D., D.L., in the Chair. [p. 747.]

The Metro-Coalite Works.

Details are published of the Metro-Coalite low-temperature carbonization plant of the South Metropolitan Gas Company at East Greenwich, which was visited by the Midland Junior Gas Association last week. [p. 748.]

Recovery of Benzole by Active Carbon.

Mr. H. Hollings and Mr. S. Hay, of the Gas Light and Coke Company, discussed the recovery of benzole by active carbon in a paper before a joint meeting of the London Section and the Chemical Engineering Group of the Society of Chemical Industry [p. 741.]

Showroom Manager Required.

A Gas Company in Yorkshire invites applications for the post of Showroom Manager—salary, £300 a year. [p. 771.]

Newcastle—London—Normanton on Gas Fuel.

A series of exhaustive tests, including a record long-distance run, has been carried out by the Whitwood Chemical Company, Ltd., of Normanton, on a lorry running on coal gas. [p. 752.]

Lea Bridge Gas Order.

An inquiry has been held at the Offices of the Board of Trade into an application by the Lea Bridge District Gas Company for an Order authorizing the Company to use certain lands for the purposes of gas manufacture. [p. 763.]

Malleable Iron Fittings for the Gas Industry.

A description is given of some of the many activities of Messrs. Crane, Ltd., at Ipswich, who manufacture many kinds of high-grade malleable iron fittings, boilers, and radiators—the Gas Industry being numbered among their largest customers. [p. 760.]

Brighton, Hove, and Worthing Gas Bill.

The Bill of the Brighton, Hove, and Worthing Gas Company, which provides that housing authorities within the Company's area shall not impose restrictions upon their tenants as to the form of light, heat, and power they should use, was considered by a Committee of the House of Commons on March 8 and 9. [p. 761.]

Forthcoming Engagements

March 23.—MANCHESTER DISTRICT ASSOCIATION.—Annual Meeting at the Midland Hotel, Manchester. Luncheon, 1 p.m. Business Meeting, 2.30 p.m. Presidential Address of Mr. F. G. Shaw.

March 24.—YORKSHIRE JUNIOR ASSOCIATION.—Meeting at Batley.

March 27.—SOUTHERN ASSOCIATION.—Annual General Meeting, Hotel Metropole, London, 2 p.m.

April 6.—NORTH BRITISH ASSOCIATION.—Spring Meeting at Perth.

April 6.—LONDON AND SOUTHERN JUNIOR ASSOCIATION.—Meeting. Paper by Mr. H. H. Brown.

April 7.—MANCHESTER AND DISTRICT JUNIOR ASSOCIATION.—Annual Dinner. Paper by Mr. H. Platt.

April 7.—SCOTTISH EASTERN JUNIOR ASSOCIATION.—Visit to Messrs. J. G. Stein & Co., Castle Carey. Paper by Mr R. Malcolm.

April 9.—I.G.E.—Meetings of Finance Sub-Committee, 1.45 p.m.; Membership Sub-Committee, 2.30 p.m.; General Purposes Committee, 3.15 p.m.; Benevolent Fund Committee of Management, 4.30 p.m.

April 10.—I.G.E.—Meetings of Council, 10 a.m.; Education Committee, 4 p.m.

April 11.—I.G.E.—Meetings of Education Executive Committee, 10 a.m.; Sir Arthur Duckham Memorial Fund Executive Committee, 2.30 p.m.

April 12.—MIDLAND JUNIOR ASSOCIATION.—Meeting. Paper by Mr. F. H. Bate.

April 30.—I.G.E.—Meeting of Liquor Effluents and Ammonia Sub-Committee, 2.30 p.m.

May 1.—I.G.E.—Meetings of Joint Research Committee, 10.30 a.m.; General Research Committee, 2.30 p.m.

May 9.—S.B.G.I.—Annual General Meeting and Dinner, Hotel Metropole, London.

1934 "JOURNAL" Directory.

Page 8. BODMIN. T. J. Greenwood appointed E. & M. vice R. Greenaway.
Page 14. CAMBORNE. T. J. Greenwood resigned.
Page 58. SANDOWN. J. P. Hall appointed E., M., & S.

EDITORIAL NOTES

Benzole Recovery

IN view of its profit-earning capacity and its national importance the recovery of benzole from coal gas has naturally been a topic much discussed in these columns during the past few years. Thanks to fiscal enactments more and more undertakings are embarking on benzole washing, and already this year we have had two accounts of the success which has attended recovery from vertical retort gas. The technique of benzole washing has been vastly improved, and a particularly attractive feature of the oil washing process is the ease with which it may be combined with the process of removal of naphthalene. The plant recently introduced for the regeneration of oil has great appeal because of its relative simplicity. It is interesting that the maximum recovery of refined benzole at gas-works during the war was in 1917, when 5 million gallons was produced by stripping. The present annual production by gas-works amounts to about 6½ million gallons. This quantity could, however, be increased five or six fold if all the coal gas made was efficiently treated—scope indeed.

The latter fact is mentioned in a paper which Messrs. Hollings and Hay presented at a joint meeting of the London Section and the Chemical Engineering Group of the Society of Chemical Industry recently. A lengthy extract and a full report of the discussion will be found on later pages and will be welcomed by our readers. The authors deal with benzole recovery by active carbon, of which they have unique experience. Following experimental work at Harrow, where the first commercial unit by British Carbo-Union, Ltd., was installed, a plant was put in at the Beckton Works of the Gas Light and Coke Company and has been in operation since August, 1932. This plant is capable of producing 20,000 gallons of benzole in 24 hours from 75 million c.ft. of coal gas containing 2·9 gallons per 10,000 c.ft. when operating at an efficiency of 92·5%. The annual production at the present time is about 3 million gallons, equivalent to a yield of 3·1 gallons per ton, and when the works produces its full output of gas the annual production will be 4½ million gallons. Costs of production are not given in the paper, which, however, contains a great deal of operating data. It may be taken that the steam consumption is 30 lbs. per gallon of benzole recovered, and the carbon replacement 6 lbs. per 1000 lbs. It is stated that when a high efficiency of benzole extraction is required the steam consumption of the carbon process is definitely considerably lower than that of the oil washing process. The steam consumption of the oil process, however, can be very considerably reduced if a sacrifice of profit-earning capacity is made by reducing the output of benzole. The paper gives the essential technical facts in studying the steam consumption and the carbon required. We look forward to a further contribution setting out the costs of the process.

Sulphur Removal

AN exceedingly important section of the paper relates to sulphur removal during benzole extraction. The average quantity of sulphur compounds in town gas to-day is about 30 grains. Most of this consists of carbon bisulphide (about 80%) and the remainder is mainly thiophene. As we emphasized in these columns on Nov. 15 last, corrosion of appliances costs our Industry dear; and apart from the money spent on maintenance of apparatus there is the question of the goodwill of the consumer. Sulphur is not the only corrosive agent in the products of combustion of town gas, but it is the most important. Sulphur compounds are bad for the lighting load, and they are bad for the employment of perfectly safe appliances unconnected with a flue. At Beckton gas is being sent out containing approximately 8 grains of sulphur per 100 c.ft., and the figure would be less than this—a matter of 6 grains—if all the gas were treated by active carbon. Benzole recovery is certainly an important factor in reducing corrosion troubles on the district. The increased efficiency of benzole extraction in the Gas Industry during the last year or two has had a marked effect upon the sulphur content of the gas distributed.

In this connection it is enlightening to turn to the paper by Messrs. Hollings and Hay. Considering first the oil washing process, the authors point out that a circulation of solvent in the ratio which suffices for the absorption of benzene will remove simultaneously all the thiophene and its higher boiling homologues. At temperatures of about 68° F. this ratio may be taken as 8 gallons of gas oil per 1,000 c.ft. of gas. On the other hand, this rate of circulation will remove only one-quarter of the carbon bisulphide. This means, however, a 40% over-all reduction in sulphur compounds by circulating quite a moderate quantity of oil in a benzole recovery plant. Of course, greater circulation means further reduction; absorption should be complete at a circulation of 32 gallons per 1,000 c.ft. Turning now to the active carbon process, this is much more efficient than the oil washing process in regard to removal of sulphur from gas. Over a period of six months' continuous working of the plant at Beckton the sulphur content of the gas was 30·5 grains at the inlet and 6·1 grains at the outlet, giving an extraction efficiency of 80%; and this result, observe the authors, "will compare favourably with the efficiency of processes which have been devised specifically for the removal of sulphur compounds."

The final section of the paper is concerned with the relative disadvantages and advantages of carbon recovered crude benzole as compared with oil recovered crude benzole. It is pointed out that the new specification for motor spirit admits of the useful unsaturated hydrocarbons being saved. When the old process of refining by acid washing was in use the limitation of sulphur in motor benzole gave rise to no difficulty, because thiophene and similar compounds were removed by the acid wash. Since the inhibitor process was adopted, however, there is more difficulty in keeping within the limit for sulphur. Now oil washing is less efficient than the carbon process in the removal of sulphur compounds from gas. Hence the benzole recovered by means of active carbon contains more sulphur than does that recovered by means of oil; and this will be regarded as a disadvantage by the benzole refiner. The authors conclude their paper by saying that, from laboratory test, when the recovery by carbon is 3·1 gallons of crude benzole per ton of coal, about 93% of that benzole distils below 120° C. "Our experience of the oil washing process indicates that either the yield of crude benzole per ton of coal is much less or the proportion of distillate below 120° C. is much less. . . . On that portion of the benzole which has to be acid refined the losses are heavier with a carbon recovered benzole than with an oil recovered benzole."

We have summarized what we consider to be the main points brought out in the paper by Messrs. Hollings and Hay. It will be obvious from the contribution what a vast amount of pioneering work the Gas Light and Coke Company have undertaken, and with what large measure of success. It would appear from the discussion that it is now wrong to regard the active carbon process as one applicable only to large-scale operation, for plants have been constructed suitable for dealing with outputs of 1,000,000 c.ft. a day and less. We repeat our hope that information on costs will soon be forthcoming.

A Great Industry

ATTENTION is once again drawn to the magnitude of the Gas Industry by the publication of the section of the Board of Trade Return (Part II.) relating to all authorized gas undertakings in Great Britain for the year 1932. This part deals with finance and prices, and is published by H.M. Stationery Office, at the price of 10s. 6d. net, postage extra. The number of undertakings dealt with is 734, which is a falling off of 15 as compared with 1931. The reduction is solely in the company concerns, and is, of course, accounted for by the policy of acquisition and amalgamation which has of recent years been a growing one in the Industry. Going back over a period of twelve years, the figures in this respect are striking. In 1920 the number of authorized companies included in the return was 494, which is 75 more than the total of 419 for 1932. During this time the number of local authority undertakings has increased by no more than 11—from 304 in 1920-21 to 315 in 1932-33.

Coming to the financial part of the return for 1932, it is seen that the amount of the issued capital (share and stock including premiums paid in respect thereof) and issued loan capital of the Companies and of money borrowed by Local Authorities (including loans borrowed and since repaid) was £208,658,247. The receipts of the undertakings on revenue account were £65,828,708, and the expenditure was £54,275,612, leaving a gross profit of £11,553,096. The receipts and expenditure were £791,097 less and £1,010,414 less respectively than in the preceding year, the gross profit being accordingly increased by 219,317.

The total paid up capital of the 419 Companies was at the end of 1932 £93,484,029, while the loan capital issued amounted to £38,022,085. The revenue figures were: Receipts £44,444,612, expenditure £37,065,193, profit £7,379,419. With regard to the 315 undertakings in the hands of Local Authorities, the total amount of money borrowed at the date named was £77,152,133, while the amount of loans repaid and balance in sinking fund was £47,395,691. The revenue figures for these Local Authorities were: Receipts £21,384,096, expenditure £17,210,419, gross profit £4,173,677. The net profit of the Local Authorities for 1932 amounted to £637,827. In the case of the Companies the profit for the year 1931 amounted to £7,292,976, while the profit of the Local Authorities for that year was £472,789.

In addition to the particulars in connection with capital, revenue, and expenditure, the return contains columns showing the maximum, standard, or basic price per therm, the actual price per therm charged on Dec. 31, 1932, showing discount (if any), and a scale of annual charges for meter rent to private consumers.

A Good Motto

"WE have at last definitely popularized the two-part tariff for domestic purposes, and the results justify our long continued effort." These words are taken from the speech from the Chair by Mr. George Balfour, M.P., at the annual meeting of the Metropolitan Electric Supply Company, Ltd., and they were accompanied by the explanation that the 24,000 domestic consumers now on this tariff show an average consumption of 1,800 units per annum, as compared with about 300 units per annum when on the flat rate. This is of special interest to our own Industry at the present time, when we are able to point to successful applications of two-part tariffs to supplies of gas, and when consideration is being widely given to the Gas Undertakings Bill. The contributed article on p. 679 of last week's issue of the "JOURNAL," dealing with this Bill, emphasized the fact that section 5 constitutes an important advance, "and appears to authorize minimum charges, block rates, and other tariffs," though only to those consumers prepared to make contracts.

There were other points of interest to us in Mr. Balfour's address. For example, we note the experience of the Metropolitan Electric Supply Company that propaganda by leaflets and literature plays but a small part in pushing sales, and that, although the Company keep intensive propaganda going all the time, "it is by the local Press, personal contact, demonstration, and canvassing that the business is secured upon a proper basis." Leaflets and literature are a necessary part of propaganda, but it is hard to imagine any method that can prove so effective as personal contact, whenever this is practicable.

Then we come to a portion of Mr. Balfour's speech which, with the exception of the first sentence, may be unreservedly commended both to our own Industry and also to the electricians. It is where he said:

> Judging by the speeches of Chairmen at recent annual general meetings, some of our friends in the gas world seem to be getting worried, if not rattled. Personally, I have always advocated a fair field and no favour. If I wished to be bitter, I should wish that they might be afflicted by the statutory "benefits" which have fallen to the lot of electricity supply undertakers. We both have our sphere of usefulness; therefore, let us not nag each other, but both adopt the motto: "May our competing industries prosper in proportion to our merit and energy." I am content, and I think shareholders in this Company might rest content, with this friendly but undoubtedly impartial and true arbitrament of fact and human understanding.

Could one wish for a better motto than this? "Nags" might get us slowly on our way, but nagging never yet got anybody anywhere. But while agreeing that the best thing we can do is to get on with our own job, we would submit that it is part of our job to put the case for gas fairly and squarely before the public. It is a case which even yet is not so fully understood as it deserves to be. Mr. Balfour himself demonstrated this in remarking that some people in the Gas Industry "seem to be getting worried, if not rattled." With a fair field and no favour, and the sphere of usefulness which Mr. Balfour concedes to us, gas people can have small cause for worry.

Yet another part of Mr. Balfour's statesmanlike speech must be mentioned here. We refer to the part in which (after expressing his pleasure at the passing of Private Legislation prohibiting local authorities from excluding gas from council houses where such authorities are owners of the local electricity supply undertaking) he declared that people must be free to make their own choice, and not be under compulsion to take one or other form of energy for lighting, heating, or cooking. The present issue of the "JOURNAL" and last week's number, containing reports of the proceedings before a Parliamentary Committee on the Bills of the South Metropolitan Gas Company and the Brighton, Hove, and Worthing Gas Company, promoted to free council house tenants in the areas of these undertakings, show how little even now is Mr. Balfour's view on the subject appreciated in some quarters.

Educational Films

IMPORTANT as is the place occupied by the film industry in our lives to-day, no one would suggest that the "screen" has yet reached finality from the point of view either of usefulness or of pleasure. We have seen films illustrating the activities of the Gas Industry and the application of tar to roads, and this is a meritorious plan which could be extended in many directions, so as to make the educational film of still wider application. Writing in *Progress*—the Bulletin of the Central Information Bureau for Educational Films, Ltd.—Mr. A. F. Harris points out that much time, money, and trouble would be saved if every employee in a factory knew precisely what functions its different machines performed. One manager, it appears, has taken photographic films of all the working departments of his establishment, and exhibited them, not only to the staff for instructional purposes, but also to clients as a form of propaganda. Here is a suggestion which is well worthy of careful consideration by those who have not yet had it brought to their notice.

There is the example of a doctor who, whenever practicable, takes a ciné camera film of surgical opera-

tions; the results in this instance being specially noteworthy, owing to his being able to place the camera so much nearer the objective than the eye of an observer could ever conveniently be. The instructional worth of such a film is obvious. Again, we recall having seen some half-dozen years ago a film prepared by an Insurance Association for exhibition at works entertainments or in works canteens during the dinner hour, with the object of impressing upon employees the necessity for care in going about their business. The title of this film was "A Chapter of Accidents," and it illustrated the adventures of two close friends, Jim Reckless and Tom Prudent. The characters of these two friends were as their names implied, and the incidents depicted in the unfolding of the tale were intensely realistic. Mention is made now of that particular film as emphasizing the help that can be rendered by the "screen" industry in connection with "Safety First" campaigns. If it is correct, as was at that time argued—that at one stage or another in every industrial accident prevention campaign general interest among employees begins to wane, and some innovation is necessary to rekindle enthusiasm—what can be better for the purpose than a realistic film of this character?

PERSONAL

Dr. F. S. SINNATT, Director of Fuel Research, has been elected a Fellow of the Institute of Physics.

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The appointment of Mr. J. P. HALL as Engineer and Manager is announced by the Sandown Gas and Coke Company, Ltd. Mr. Hall, who has been Acting Manager for the past three months, came to the Company from Loughborough in December, 1932.

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Mr. ROBERT ROBERTSON, Engineer and Works Manager to the Bristol Gas Company, has been elected a Member of the Institution of Civil Engineers.

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Mr. J. M. CAMPBELL, Engineer and Manager of the Isle of Thanet Gas Light and Coke Company, has been appointed a Justice of the Peace in the Borough of Margate.

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Mr. OCTAVIUS THOMAS, Engineer and Manager of the Gas and Water Department of the Rhondda Urban District Council, will be retiring early next month. That he may have many happy years before him in which to enjoy his greater leisure will be the wish of everyone who knows Mr. Thomas.

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Mr. T. J. GREENWOOD, who has been Manager of the Camborne Gas-Works for the past 13½ years, was on Tuesday last appointed Engineer and Manager of the Bodmin Gas Consumers Company, Ltd. He will take up his duties at Bodmin early in April.

OBITUARY

The death is announced of Mr. E. LLOYD PEASE, Chairman of Messrs. Ashmore, Benson, Pease, & Co., Ltd., of Stockton-on-Tees. Mr. Pease had not enjoyed his usual health for some time, but was at work as recently as March 13, so that the end came unexpectedly on Thursday morning last. He was also Chairman of the Power Gas Corporation, Waste Heat and Gas Electrical Generating Stations, a Director of Cargo Fleet Iron, South Durham Steel and Iron, and Weardale Steel, Coal, and Coke Companies. The interment took place on Saturday at Darlington.

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The death recently occurred in Paris at the age of 79 years of M. JAMES L. P. C. CHAPPUIS, Chief of the Physical Research Laboratory of the Société du Gaz de Paris. Deceased, after a scientific education, was at the age of 27 years appointed in 1881 to the Chair of General Physics at the Ecole des Arts et Manufactures in Paris—a position he held until 1922. During this long period he carried out a considerable amount of research work, particularly in connection with vapour tensions, the critical points and vaporizing temperatures of liquefied gases, X-rays, and refraction. On leaving the Ecole des Arts he accepted an invitation of the Société du Gaz de Paris to organize and control its physical research laboratories. During the past few years M. Chappuis devoted considerable attention to developing the industrial uses of gas and also to the use of compressed gas for the running of the engines of motor vehicles.

CORRESPONDENCE

A Whirlwind at Grantham.

SIR,—An occurrence at this works at 4.30 p.m. on Saturday, March 10, seems to be worth recording. I was a short distance from the works at the time, and the following is a brief account of what occurred. After a very stormy afternoon in the district, with thunder, lightning, hail, and rain, a tremendous blast of air, which can only be described as a whirlwind, struck the gas-works. Practically every roof was damaged, nearly half the slates being removed from the retort house, and large holes were made in other buildings, including my own house. On looking at the district pressure recorder at the works, I found this had been put out of action at the time mentioned, presumably by the sudden fluctuation in pressure.

The gasholder supplying the town at the time is a two-lift column guided one of 450,000 c.ft. capacity, built by Clayton, Son, & Co. in 1885. It was cupped at the time, and throwing a pressure of 6 in. The town pressure at the time was governed to 3½ in., and the output of gas would not have been very heavy at that time on a Saturday afternoon. The pressure recorder at the showroom half-a-mile away, which was not affected by the whirlwind, shows a sudden drop from 3½ in. to 1½ in. at 4.30 p.m. followed by a practically immediate rise to 4½ in., due presumably to oscillation of the governor in righting itself, and an equally sharp fall to the normal pressure of 3½ in., at which it remained. The fall and subsequent rise of the recorder are so close together that only by the closest examination can it be seen that the fall occurred before the rise. A careful examination of the holder and the adjacent spiral guided holder revealed no damage of any sort, though the force of the upward thrust against them, as suggested by the pressure drop, must have been terrific.

The "whirlwind" did not last for more than three minutes, and yet during this brief period, apart from the foregoing, considerable damage was done in the part of the town adjacent to the works, and innumerable stalls in the open market, with their contents, were scattered widespread.

Yours, &c.,
J. E. YOUNG,
Manager.

Grantham Gas Company,
March 14, 1934.

Gas from the Grid.

SIR,—At the recent meeting of stockholders of the Sheffield Gas Company the Chairman ably compared the respective advantages of gas and electricity. He rightly claimed that "one of the advantages which gas has over electricity is its reliability, while the unreliability of electricity is proverbial and provides a daily headline in most of our newspapers."

An important question which should be considered concerns the reliability of the supply of oven gas such as the Sheffield Gas Company buys from neighbouring collieries. While this Company may have provided for the emergency of the coke oven gas failing, and have suitable stand-by plant which could be quickly brought into action when required, it is an open secret that some of the smaller gas undertakings which purchase oven gas have made no similar provision, and their consumers would be without gas almost immediately if the coke ovens ceased to function. What a disgrace then for gas and a harvest for electricity.

Yours, &c.,
"SAFETY FIRST."

March 14, 1934.

THE NEWS OF THE WEEK

A Site for a New Gas-Works in Bradley Road is being considered by the Nelson Corporation. Gas is now produced at the Brierfield Works.

The Stourport Gas Company have just secured the public lighting contract for the whole of the street lamps in the Stourport Urban District for a period of five years.

An Address on the Gas Industry was given by Mr. J. B. Balmforth, Engineer and Manager to the Bingley Gas Department, before the newly-formed Keighley Rotary Club.

Gas Hair Waving Machine.—The Oldham Corporation Commercial Superintendent has arranged with the makers and demonstrators of a new portable machine for waving hair, operated by gas, to give demonstrations at the municipal showrooms.

Price Reduction.—The Directors of the Walton-on-Thames and Weybridge Gas Company have decided to reduce the price of gas by ½d. per therm, as from the readings of the meters for the Lady Day quarter. The new price will be 11d. per therm.

A Successful Cookery Demonstration was given on March 13 at the Snitterfield Women's Institute. Snitterfield is a village in the area of the Stratford-upon-Avon Corporation Gas Department. Miss M. Wood, who gave the demonstration, is on the staff of the Gas Department.

Illuminating Engineering Society.—By the courtesy of Messrs. Glyn, Mills, & Co., and Messrs. Lever Brothers, Ltd., an opportunity of inspecting the lighting of their premises will be afforded to members of the Illuminating Engineering Society on Thursday, March 22, commencing at 5.40 p.m.

Floodlighting of a Model Home.—In connection with our photograph of a model home floodlighted by gas by the Cheltenham and District Gas Company ("JOURNAL" for March 14, p. 681), we have been asked to mention that the equipment used consisted of two 12-light strip lanterns by Foster & Pullen, Ltd., of Bradford.

A Series of Cookery Demonstrations and exhibition of modern gas appliances by the Sandown Gas and Coke Company, Ltd., in conjunction with Radiation, Ltd., was held in the Town Hall, Sandown, recently. The exhibition was opened by the Chairman of the Directors, Mr. W. H. Findon, C.C. The Lecturer was Miss M. K. Eason. Over 1,100 people attended, and the cake competition proved very popular, over 80 entries being received.

In an Address to the Local Rotary Club, Mr. J. H. Ranft, Engineer to the Lytham St. Annes Gas Department, said the amalgamation of all the gas resources of the country on the lines of the electric grid was to be recommended. The transmission of gas over long distances presented no engineering difficulties. The ultimate goal should be in the co-ordination of coal, gas, and electricity, for the national good, in which each fuel was applied to its most efficient use.

Messrs. Gibbons (Dudley), Ltd., show a net profit for the year, after providing for depreciation of £7,638, which, added to the amount brought forward from last year, £10,122, makes a total of £17,760. From this amount the full 7% preference dividend, free of income-tax, for the year, was paid on June 30 and Dec. 31, 1933, absorbing £2,100, leaving a balance of £15,660 to be dealt with. The Directors recommend that a dividend of 5% on the ordinary shares, less income-tax, be paid, which, after payment of further Directors' fees, leaves to be carried forward to next year £10,195 3s. 8d.

The Fire which occurred at the premises of Messrs. New Geysers (1931), Ltd., 24, 25, and 27, Addington Square, London, S.E. 5, on Friday, March 9, resulting in the explosion of two acetylene cylinders, caused rather serious damage to the building and part of the machinery. They are pleased to state, however, that owing to their recent new extension buildings, and the acquisition of temporary premises, they will be able to carry on and execute orders as usual, but would appreciate the co-operation of their numerous friends in the matter of advising requirements as far in advance as possible.

A Meeting of the Sir Arthur Duckham Memorial Fund Executive Committee will be held in the Council Chamber of the Institution of Gas Engineers, 28, Grosvenor Gardens, S.W. 1, on Wednesday, April 11, at 2.30 p.m.

A Change of Address is announced by Mr. Harold Whitehead and his staff, who have moved their headquarters to Ship House, 20, Buckingham Gate, S.W. 1 (Telephone—Victoria 4425). This firm specializes in market research, industrial administration, business management, sales organization and training, merchandizing, and their related subjects.

Auction of Shares.—On Friday last Messrs. Brackett & Sons, of Tunbridge Wells, submitted nine lots of Gas and Water Companies' shares to public auction, and every lot was sold under the hammer. The following prices were obtained: £400 East Grinstead Gas and Water Company's 7% (maximum dividend) "C" shares realized £700; £650 sliding-scale stock in the Tunbridge Wells Gas Company realized £977 10s.; and £244 5% maximum stock in the Tunbridge Wells Gas Company realized £257.

The Town Council of Dunfermline have arrived at the decision to take over the Kincardine-on-Forth Gas Undertaking at a cost of £1,000, and instructions to that effect have been authorized to be forwarded to the Fife County Clerk. According to the terms of the agreement, the price of gas to the consumer is to be 5s. per 1,000 c.ft., a considerable reduction over the price obtaining hitherto. The Town Council's action is based on a guarantee that gas will be the form of street lighting for the next ten years.

The Annual Staff Dance of the Parkinson Stove Company, Ltd., Stechford, was held on Friday, March 16, at the Imperial Hotel, Birmingham. Well over a hundred attended the festivities and spent a merry evening. During an interval, the Managing Director, Mr. R. J. Rogers, referred in felicitous terms to the presence of the Deputy-Chairman, Mr. W. W. Parkinson. Mr. Parkinson, in reply, said it was a great pleasure for him to be present and to be with so large a gathering of the Stove Company's Staff.

Vickers, Ltd.—The profit and loss account shows that (*a*) the net trading profit for the year amounts to £816,361, from which must be deducted income-tax, debenture interest and other expenses as shown by the profit and loss account, £272,997, leaving a balance of £543,364; (*b*) the dividends on the preference share capital for the year ended Dec. 31, 1933, already declared, are £418,190, leaving a balance of £125,173, to which must be added the amount brought forward from the year ended Dec. 31, 1932, £222,022, making a total of £347,196. This the Directors recommend should be appropriated as follows, viz.—(*a*) Payment of dividend of 4% less income-tax on the ordinary share capital, which will absorb £123,154; (*b*) carry forward to next year the sum of £224,041.

Training for the Gas Industry.

An event anticipated with pleasure and enjoyed alike by staff, old students, and undergraduates is the annual dinner of the Fuel Department of Leeds University. At this year's gathering—it is quite an informal affair—Major Geoffrey H. Kitson, Chairman of the Leeds Gas Department and a Past-President of the British Commercial Gas Association, was the guest of the evening.

In a short address which was greatly appreciated by those present, Major Kitson, proposing the toast of the Fuel Department, asked students to bear in mind that their work at the University must have direct relationship to the sales side of the Gas Industry. Many fail to appreciate that the future of gas is exceedingly bright, and he places much store by the research work such as is carried out at the Leeds University.

Prof. J. W. Cobb, who was in the chair, endorsed Major Kitson's remarks that the Gas Industry must understand not only how to make its products—and it is not a one-product industry—but how best to utilize these products. Nowadays a different kind of advocacy is needed, and it is insufficient for the salesman to rely solely on certain qualities of persuasion—tact and so on. A good salesman to-day must be able to give chapter and verse for the statements

THE NEWS—*continued.*

he makes. He should have a nodding acquaintance with a number of industries, and a thorough knowledge of those industries likely to use gas. The obtaining of a degree, emphasized Prof. Cobb, is a start and a start only; and the training at Leeds ought to be regarded as an apprenticeship to the Industry—an apprenticeship which gives the student a grasp of principles.

Reply to the toast on behalf of the Staff of the Department was made by Dr. A. L. Roberts, while Mr. R. Dally, of the British Gas Light Company, Ltd. (Hull Station), responded on behalf of the old students. The progress of old students of the Fuel Department, said Mr. Dally, provides convincing proof that the training given at Leeds University is adequate for a useful and successful career in the Gas Industry.

Mr. H. C. Millett explained that beer now cost 6d. a pint in the Refectory, and that therefore he had much pleasure in responding on behalf of the present students.

Date Marking on Conveyor Belting.

The importance of knowing exactly to a month the age of conveyor belts will at once be appreciated, and to this end Messrs. Mavor & Coulson, Ltd., of 47, Broad Street, Mile-End, Glasgow, have arranged that, in future, belts supplied with M. & C. flat or troughed belt structures will be marked in such a manner as to enable this information to be obtained at a glance, no matter how long after purchase.

Two coloured stripes will run through the belt fabric, right along the length of the belt, and the colour and the distance relationship of the stripes, when compared in cross section with a diagram on a card supplied by M. & C. will tell the year and month of manufacture.

New Coke Oven Installation.

The Coppée Company (Great Britain), Ltd., of 44, Grosvenor Place, London, S.W. 1, have secured the order for a battery of Coppée underfired regenerative coke ovens for the Hardwick Colliery Company, Ltd., of Heath, near Chesterfield.

The new installation will have a throughput of 2,600 tons of washed coal per week (dry basis), and will comprise a 500-ton reinforced concrete service bunker, 19 Coppée underfired regenerative ovens, complete with coke oven machinery, quenching station, and coke screening and cutting plant. There will also be a breeze drying and grinding plant for preparing the coke dust for mixing with the coal before charging the ovens.

On the bye-product side there are included new primary coolers, turbine driven exhausters, final cooler, and naphthalene washer, new tar and ammoniacal liquor storage tanks, and water cooling plant. The existing crude benzole plant is being overhauled and a complete Coppée benzole rectification plant is being added.

In 1910 the Hardwick Colliery Company placed an order for 50 Coppée waste-heat ovens which were built at Hardwick Colliery, and it is on the site of these ovens that the new battery will be installed. In 1917 25 additional Coppée waste-heat ovens were ordered, and these latter will be kept in operation until the new plant is ready to work.

Success of the First Gas Grid.

Large Sales Increase at Sheffield.

At the annual meeting of the Sheffield Gas Company the Chairman, Lieut.-Col. H. K. Stephenson, D.S.O., LL.D., J.P., was able to report an increase in the sales of gas of over 7%.

The South Yorkshire gas grid, he explained, had now been in operation for over twelve months, and he thought they might say that very satisfactory progress had been made. In their case the grid scheme was rather the culmination of previous pioneer work than an entirely new venture, for they commenced taking coke oven gas as long ago as 1918, and had been linking up fresh coke ovens ever since.

Their 1931 Act of Parliament opened up a new vista, and they were now pursuing the larger policy which that Act made possible.

Although the scheme was in the nature of an experiment it marked an important stage in the development of gas distribution and may have far-reaching results. Small though it might be by comparison with the much-advertised electricity grid, their coke oven gas area embraced something like 300 square miles, and the success of their enterprise must undoubtedly act as an inspiration to gas undertakings in other parts of the country.

Under their Act they had added three more coke ovens to their sources of supply—namely, the South Yorkshire Chemical Works, Parkgate; the Sheffield Coal Company, Beighton, and the Wharncliffe Silkstone Colliery Company, Tankersley, so that they were now taking gas from no fewer than six different coke ovens. They hoped to link up with at least one more coke oven during the present year.

Their Company always had regard to the necessities of the industries in the area which it served and led the way in the provision of cheap gas, and they had now succeeded in getting the price for the largest quantities down to the pre-war level of 10d. per 1,000 c.ft., or 2d. per therm.

A "Regulo" Treat for Teddy.

This photograph of a window display at Stretford indicates that the child of to-day has confidence in gas service.

Scottish Junior Gas Association.

(Western District.)

The Annual Business Meeting of the Scottish Junior Gas Association (Western District) was held in the Royal Technical College, Glasgow, on March 10. Mr. JOHN GREIG, Glasgow, the Vice-President, was in the chair, and after the minutes of the previous meeting had been read and approved the Hon. Secretary and Treasurer presented his reports for the 30th Session. The Office-Bearers for the coming session were then elected.

President.—Mr. John Greig, Glasgow.

Vice-President.—Mr. Alex. Bujnowski, Glasgow.

Members of Council.—Messrs. W. A. Currie, Glasgow; K. Graham, Glasgow; W. Kirk, Motherwell; R. A. MacLaren, Newton-on-Ayr; A. Shand, Falkirk.

Hon. Secretary and Treasurer.—Mr. J. K. Campbell, Glasgow.

Auditors.—Messrs. C. Gill, Glasgow; and J. Leckie, Motherwell.

After the formal business had been conducted a paper on "Plane Surveying and its Application to Gas Engineering" was read by Harold S. Milne, B.Sc.(Eng.), Greenock—see later pages.

THE NEWS—continued.

SIR ARTHUR DUCKHAM MEMORIAL FUND

Official List of Donations from March 10 to 16

Name and Town.	Amount. £ s. d.
Col. K. C. Appleyard, Birtley	2 2 0
Barnet District Gas and Water Company	20 0 0
Barnstaple Gas Company	5 5 0
Basingstoke Gas Company	3 7 0
Bath Gas Company	50 0 0
Sir Russell Bencraft, Southampton	1 1 0
Bishop's Stortford, Harlow, and Epping Gas and Electricity Company	5 0 0
Blyth Gas Company	3 3 0
British Gas Light Company, Ltd., London	100 0 0
Thomas Carmichael, Portsmouth	2 2 0
Mrs. Charles Carpenter, London	5 5 0
Clevedon Gas Company	2 2 0
Commercial Gas Company	10 10 0
Compagnie Générale de Construction de Fours, Montrouge (Seine), France	25 0 0
Cradley Heath Gas Company	5 5 0
C. W. Crawshaw, London	2 2 0
Dartmouth Gas, Coke, and Coal Company, Ltd.	2 2 0
Dawlish Gas and Coke Company, Ltd.	1 1 0
Thomas Goulden, Ingatestone	2 2 0
Great Yarmouth Gas Company	5 5 0
W. George Head, Wimbledon	2 2 0
G. A. Hebden, Rawmarsh	1 1 0
A. C. Hovey, London	5 5 0
Ipswich Gas Light Company	34 0 0
William C. Jackson, Neath	0 10 6
"J. E. D.," 240, London	5 5 0
Kildwick Parish Gas Company	4 0 0
Leighton Buzzard Gas Company	4 4 0
George William Martin, Houghton-le-Spring	0 10 6
A. H. Middleton, Consett	5 5 0
Hermann Müller, Hamburg	1 6 0
J. Watson Napier, Thorncliffe	1 1 0
Old Blackheathen Club—	
Donald McDonald	1 0 0
Edward Provis	3 3 0
Commander W. B. Rowbotham, R.N. (Retd.)	0 10 0
Pinchbeck, Ltd., London	2 2 0
Ryde Gaslight Company	10 10 0
J. W. Scott, Manchester	1 1 0
Frederick R. Simms, Chislehurst	1 1 0
Sleaford Gas Company, Ltd.	2 2 0
H. C. Smith, Tottenham	5 5 0
John Howard Smith, London	20 0 0
Southbank and Normanby Gas Light and Coke Company, Ltd.	2 2 0
South Metropolitan Gas Company	26 5 0
Arthur Valon, London	10 10 0
E. Watson, London	0 10 6
Wellingborough Gas Light Company, Ltd.	5 5 0
Arthur Wilkinson, Beighton	0 10 6
Woodall-Duckham Companies; Directors and Staff (First Donation)	100 0 0
Worksop Gas Company	2 2 0
York Gas Company	31 13 6
Donations (51) paid above	£ 542 16 6
Donations (239) paid previously	3,233 2 6
Total Donations (290) paid	£3,775 19 0
Donations (24) promised	2,472 14 0
Total Donations (314) paid or promised	£6,248 13 0

Colonial Gas Association, Ltd.

At a recent Meeting of the Directors of the Colonial Gas Association, Ltd., in Melbourne, interim dividends were declared for the half-year ended Dec. 31 last, at the rate of 4%, less income-tax, on the preference shares, and at the rate of 3%, less income-tax, on the ordinary shares.

Exchange will be deducted from these dividends at the rate ruling on the date the dividend was declared—namely, £100 in London for £125 10s. in Melbourne.

The dividends due to shareholders on the London Register will be payable in London on March 29. The transfer books of the Company were closed as from 5 p.m. on Tuesday, March 13, and will be opened at 5 p.m. on Thursday, March 29.

Housewifery a Profession.

"Housekeeping should be one of the recognized professions," remarked Eileen Murphy, the Household Management Expert of the British Commercial Gas Association, in an address at Halifax to members of the newly-formed Halifax women's branch of the Yorkshire Gas Development Association to-day.

"Any woman who runs her home well is a manager, an accountant, a nurse, a cook, and an interior decorator, all rolled into one. She is something more than a business woman. Business women have regular hours which leave them plenty of time to amuse themselves. The housewife needs just as much if not more amusement, for hers is the hardest task. The only way she can gain time for that recreation is by using up-to-date, labour-saving devices in her home.

"A workshop manager requires an unfailing, controllable supply of heat. The housewife is equally in need of such a supply to help her in her household tasks. Unless she can obtain it, she becomes the slave of her home instead of its mistress. Cooking, hot water, warmth, refrigeration—all require heat to operate successfully.

"The Gas Industry provides everything the housewife needs. Gas fires give out rays that most approximate to sunshine: the gas cooker gives you the exact heat you want at the moment you want it. Constant hot water is always available to the gas-run home. Gas irons, gas refrigerators are at the housewife's command—the poorest can avail themselves of their labour-saving qualities by putting a penny in a slot-meter.

"When you buy gas, you buy British, for you are helping to keep 70,000 miners at work, in addition to providing bye-products for such necessaries as drugs, dyes, and motor car fuel."

Gas-Works Design.

At a meeting of the Manchester Association of Engineers held on March 9, Mr. A. L. Dawson (West's Gas Improvement Company, Ltd.) read a paper entitled "The Draughtsman as Designer—His Scope and Restrictions."

Dealing with the design of the coke extractor of a continuously-operated vertical retort producing coal gas, Mr. Dawson stated that there were, at the present day, only two highly successful designs for the extraction of coke at regular and readily adjustable varying rates, and while they were distinctly dissimilar in construction, each embodied the principle of a helix, and it was indeed an interesting reflection that in each case the design was to-day substantially the same as that of the original mechanism patented over 24 years ago.

While the general trend of the inventor-designer was to mechanize operations previously effected by hand, it might be an interesting digression to put forward a concrete example in which it was proved retrograde to attempt to mechanize the charging of coal to vertical retorts.

In addition to the automatic extraction of coke from the base of the retorts, it was considered to be one of the first problems to charge the coal to the retorts automatically. Several original ideas were conceived, and, in fact, one device was actually put into operation, consisting of series of slowly revolving wipers, which swept a definite quantity of coal over a receiving plate, and thence into coal hoppers having direct communication with the retort. It was very soon discovered, however, that while the automatic coal-feeding mechanism behaved perfectly, the coal actually in the retort refused to descend in the same harmonic rhythm as that of the incoming coal, and that, if left to itself, the coal would follow the charge through the retort without any mechanical assistance.

In consequence the automatic coal-feeding mechanism proved to be superfluous, and it was soon replaced by simple coal-feed boxes fitted with a gas-tight valve, opened every two hours to allow the boxes to fill up once again.

Incidentally, the amount of coal left in the boxes after the interval of two hours proved a useful "tell-tale" as to the passage of coal to the retort.

An example of the reverse order might be quoted—one of the multitudes of successful labour-saving appliances for the handling of material.

When the crane and gantry and also the overhead telpher system became popular for the handling of coke in and out of stock, the more common method was to push out the skips on under-carriages to a point within the operating

THE NEWS—*continued.*

scope of the crane or telpher, the skip being attached by hand to the lifting bale.

With the advent of conveyors of a certain type for the handling of such friable material as coke, the labour involved in the pushing about of the cumbersome skips was eliminated, but as often as not it was desired to stock the surplus coke in the yard and reclaim it as required, again involving the use of either a crane or overhead telpher.

The surplus coke, handled by means of a conveyor, to a receiving hopper, was in the earlier days fed by a hand-operated chute arrangement into the crane or telpher skips, thus it was essential for two men to be in attendance, one to operate the telpher and the other to operate the skip-filling chute. Very soon, along came the inventor with an automatic skip-filling device, in which the weight of the descending skip was utilized to operate automatically the discharging doors.

A machine which fulfilled a similar purpose was one in which the angle of repose of the coke governed the filling of the skip.

Reversals of previous designs had often proved a success, and should inventor-designers find themselves at any time lacking in inspiration of new ideas, the lecturer suggested that they led their imagination into channels precisely the reverse of the present-day order.

A Notable Centenary.

Watford and St. Albans Company Celebrate their 100th Anniversary.

The history of a city, a manor, a parish, or a hundred years' old company stimulates interest according to the relative intrinsic importance of the subject, so that a centenary in the Gas Industry must always prove of interest to our readers.

For a hundred years the Watford and St. Albans Gas Company have unfailingly served the public in their large area of supply, and at the present time they are celebrating their centenary in a manner which will surely appeal to the public in their district. An attractively produced brochure, containing many interesting features of old Watford and photographs of past and present officials of the Company, has been published to mark the centenary, and in this is given a brief sketch of the history of the town and a survey of the progress of the Gas Industry.

The Watford Gas and Coke Company, it is stated, was formed on Jan. 2, 1834, with a capital of £2,500, and the first recorded Directors' meeting was held in August of that year. An amusing minute appears for Sept. 1, of the same year, when arrangements were made "to light the town as a trial preparatory to a regular *flare up*." Apparently the lighting was quite a success, as the Directors shortly afterwards gave a dinner to the lighting inspectors and also to the shareholders of the Company.

The coal carbonized in the first years amounted to 200 tons per annum—a quantity which has increased now to over 80,000 tons per annum. The struggle in the early years with regard to the works problems was not a light one, and various complaints were lodged of the smell which emanated therefrom, while further complaints were received to the effect that the wash from the works had destroyed many fish in the Colne. In 1835 the monthly coal bill reached the sum of £19 11s. 11d. (16¼ tons), and the monthly receipts for the 50 public lamps were £22 10s. Private accounts to the extent of £27 17s. 3d. were recorded, and the residual products sold for the month totalled £16 11s. 4d. The first mention of a dividend was at the Annual General Meeting held in June, 1836, when 5% on the increased capital of £3,000 was declared.

It is mentioned that in the 'fifties and 'sixties the Directors held their meetings at various inns in the town, the Chairman, no doubt, having first choice with his favourite place and the other Directors choosing in turn. In 1855 it is noted that four Directors audited the accounts and certified them as correct! The first record of Directors' fees occurs in 1863, when the sum of £25 was divided among the eight members of the Board. The salary of the Secretary at that time was the munificent sum of £40 per annum.

Technical Advice Obtained.

In 1867 the need for expert engineering advice was realized, and a most important step was taken in the appointment of Mr. Henry E. Jones (father of the present Chairman, Mr. Frank H. Jones) as Consulting Engineer, and a few years later an issue of £2,000 was made, which enabled the works to be improved and a gasholder built. The first example of forceful advertising was in 1884, when an exhibition of gas cookers was held at the Corn Exchange, and a liberal discount offered. In 1895 the prepayment meter system was introduced.

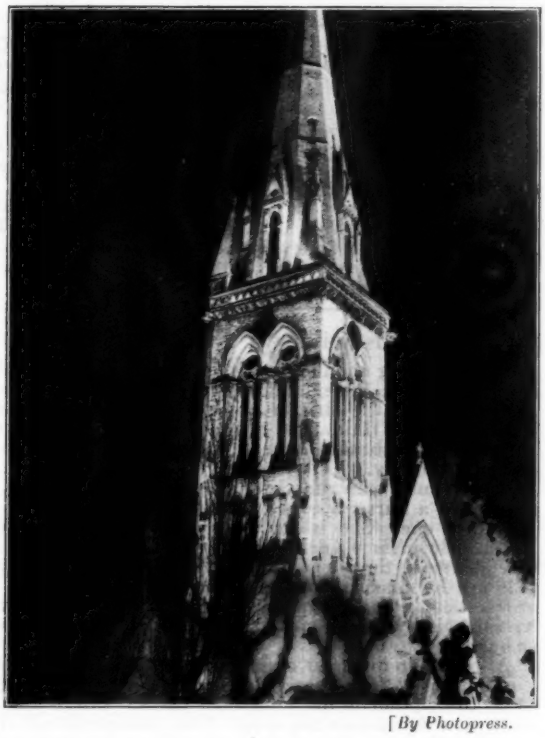
The twentieth century arrived, and sure and continued progress was recorded; issues of stock were made from time to time; the works were improved; and the number of consumers increased. Mr. Frank H. Jones was appointed to the Board in 1906 on the retirement of his father. To celebrate the passing of the Watford Gas Act in the same year, the Directors entertained all the employees to a supper, at which everything went quite successfully—the only incident not previously arranged being *the failure of the electric light for about ten minutes.*

In 1909 the co-partnership scheme was instituted, and in 1928 a pension scheme was commenced. Several surrounding gas undertakings have been absorbed by the Watford Company during recent years—among them St. Albans, Elstree, and Boreham Wood, Hemel Hempstead, Welwyn and Hatfield, Harpenden, and Rickmansworth, the last named being effected as from the end of the present month. This gives the Company an area of 220 sq. miles, and employment is afforded for 670 employees. There are 46,000 consumers, and the capital employed amounts to £1,214,296. The amount of gas sold last year was 1,347,716,700 c.ft.

In further celebration of their Centenary, the Company have taken a striking full-page advertisement in six local newspapers, giving particulars of free gift schemes and cookery demonstrations which are to be held. In addition, special advertising is being carried out by means of lorry and hoarding posters.

On the completion of 100 years' service, the Watford and St. Albans Gas Company and all connected therewith can look back with natural pride to their achievements in the past and face the future with complete confidence. We congratulate Mr. George Wilks, the Secretary and Commercial Manager, on the production of the excellent brochure which marks so outstanding a landmark in the history of the Company.

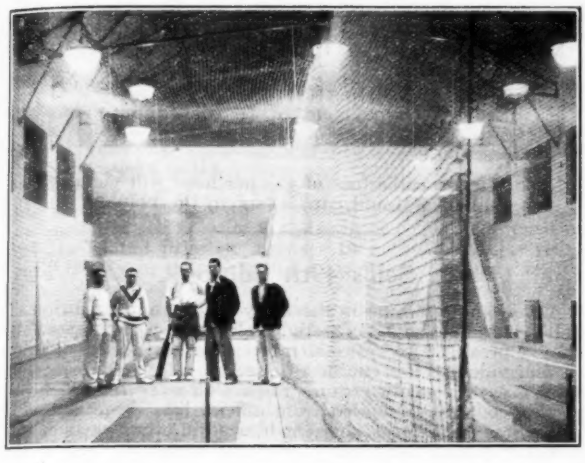
Church Floodlighting by Gas.



[*By Photopress.*

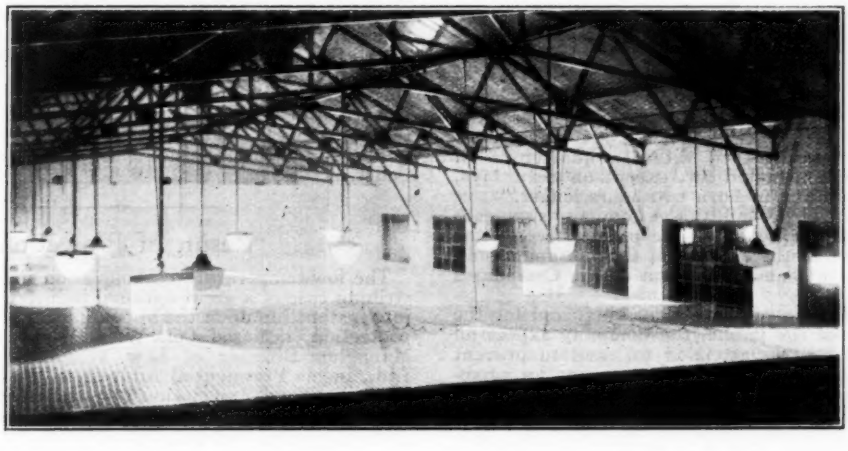
A number of churches in the Parishes of Richmond and Kew are being floodlighted by gas during the two weeks of the Richmond Youth Campaign. Our photograph shows St. Matthias, Richmond Hill, floodlighted by 80,000 *c.p. gas installation. The large circular reflector projectors used are made by Wm. Sugg & Co., Ltd. The candlepower of the beam is* 16,000, *and some of the lamps have been fitted with special mirror glass reflectors. These reflectors are all of heat resisting glass which has been specially treated. They are used in the rather large throw necessary to reach the towers. Projectors of the same type are now being successfully employed to floodlight the locomotive sidings at the Camden Town Yards of the L.M.S. Railway.*

Cricket School Lighted by Gas



[*Photo. by N. G. Ibbett.*

The Surrey School of Cricket, Sutton, is lighted by gas for the following reasons: Reliability; its close resemblance to daylight; the absence of harshness and the kindly nature of gaslight to the eye, thus reducing the risk of fatigue to the eyes, which is absolutely necessary as one has to follow the flight of the ball from the time it leaves the bowler's hands; assistance to ventilation; additional over-head warmth, thus preventing cold down-draught so often experienced in lofty buildings. The installation consists of twelve Sugg 600 C.P. "Bon Marché" lamps fitted with No. 2 mantles and distant control. Heavy wire cages were fitted instead of opal bowls, to prevent damage from the balls. The official opening took place on Feb. 24, and Lord Ebbisham and Mr. H. D. G. Leveson-Gower both mentioned in their speeches that no one could appeal to the umpire against bad light. A "Bon Marché" lamp is installed in the gallery for lighting; a Potterton boiler and "K.C.U." heaters supply hot water in the kitchen and lavatories; gas is used for cooking; and the building throughout is heated by gas steam radiators. The whole installation was carried out by the Wandsworth and District Gas Company.



[*Photo. by N. G. Ibbett.*

SHOWING THE GAS LIGHTING UNITS ABOVE THE PRACTICE NETS.

Musselburgh and the Gas Company.

At a Meeting of Musselburgh Town Council the minute of a previous meeting, which was private, was read. It showed that the Council had been further considering the recent application by the Musselburgh Gas Company for a feu of land belonging to the Common Good of the burgh, and situated immediately to the north of the gas-works, so that the Company might make extension of these rendered necessary by increased business.

At the private meeting the Town Clerk had reminded the Council that an action for interdict against the Council for proposing to give off ground in the same neighbourhood for the same purpose had succeeded in 1914, and to get round that interdict it would be necessary to promote a Provisional Order, and that whether such promotion succeeded or not, it would be reasonable to have the Gas Company meet all the Council's costs. It had been moved to reject the application of the Gas Company, and it had also been moved to delay action to allow the Gas Company to relieve the congestion of their existing works by transferring house and office buildings to a vacant feu across the road leading past the gas-works to the beach.

By a majority, the private meeting of the Council had agreed to the second alternative, without Provost Lowe, who is Chairman of the Gas Company, intervening in the discussion. Finally the Council confirmed the minute of the private meeting in question.

Visit to the Works of Fletcher Russell.

The Manchester and District Junior Gas Association and the Yorkshire Junior Gas Association paid a joint visit to the Warrington Works of Messrs. Fletcher, Russell, & Co., Ltd., on March 14. They were welcomed by Mr. J. H. Kemp (Director) in the absence of Mr. Clark (Chairman) and Mr. Russell (Managing Director).

The visitors were taken through the various departments, following the raw material from its entrance into the works to its finished state. They saw the cupolas, the mixture of metals, stores, foundry, and moulding shops, and presses for forming trays, shelves, &c.

The party then adjourned to the Recreation Room, where Dr. D. A. Winter delivered his lecture, "The Use of Coal Gas for the Production of Radiant Heat."

High tea was served in the canteen. Mr. T. H. WILLIAMS (President of the Manchester Juniors) moved, and Mr. B. THORP (President of the Yorkshire Juniors) seconded, a vote of thanks to the firm, which was replied to by Mr. Kemp on behalf of the Directors. Upon leaving, each of the visiting members of the two Associations was presented with a card tray and plaque which had been cast in the foundry.

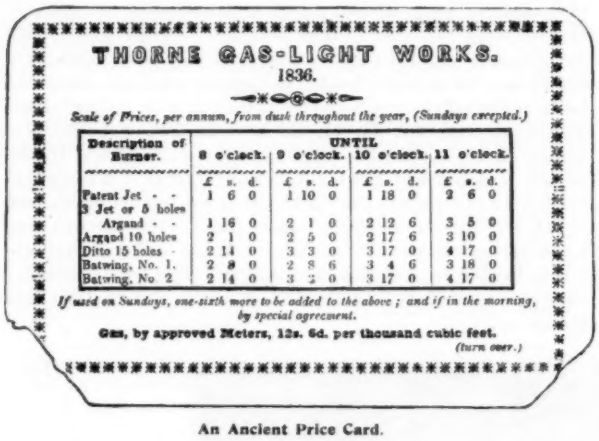
THE NEWS—continued.

A Relic of By-Gone Days.

Price Card of a Hundred Years Ago.

The accompanying illustration has been reproduced from an original price card, dated 1836, sent to us by Mr. A. Wilkinson, Engineer, Manager, and Secretary of the South Yorkshire and Derbyshire Gas Company.

It relates to the late Thorne Gas Light and Coke Company, Ltd., which concern was purchased by the South Yorkshire and Derbyshire Company at the beginning of 1933. It will be noted that gas, by approved meter, was charged at the rate of 12s. 6d. per 1,000 c.ft., while, apparently, gas consumed on Sundays cost more than on week days.



THORNE GAS-LIGHT WORKS.
1836.

Scale of Prices, per annum, from dusk throughout the year, (Sundays excepted.)

Description of Burner.	UNTIL 8 o'clock.	9 o'clock.	10 o'clock.	11 o'clock.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Patent Jet - -	1 6 0	1 10 0	1 18 0	2 6 0
3 Jet or 5 holes Argand - -	1 16 0	2 1 0	2 12 6	3 5 0
Argand 10 holes	2 1 0	2 5 0	2 17 6	3 10 0
Ditto 15 holes -	2 14 0	3 3 0	3 17 0	4 17 0
Batwing, No. 1.	2 8 0	2 8 6	3 4 6	3 18 0
Batwing, No. 2	2 14 0	3 2 0	3 17 0	4 17 0

If used on Sundays, one-sixth more to be added to the above; and if in the morning, by special agreement.

Gas, by approved Meters, 12s. 6d. per thousand cubic feet.

(turn over.)

An Ancient Price Card.

The following is reproduced from the reverse side of the card:

The lights to be extinguished within a quarter of an hour after the time contracted for, except on Saturdays, when they will be allowed to burn two hours longer.

The service pipes will be laid at the Company's expense to the front walls of the houses in the public streets; the interior fittings to be at the expense of the consumer, subject to the approbation and inspection of the Company's agent.

To promote the success of the undertaking, and for the common advantage of the public, the Company expect all regulations will be strictly attended to; and to prevent mistakes each consumer will be required to sign an agreement with the Company's agent, to comply with the same.

The Company earnestly recommend the use of meters, being the fairest mode that can be adopted between them and the consumer, the latter paying for no more gas than is actually consumed; it prevents all disputes, more particularly as to time of burning; allows the consumer to use burners at his own discretion; and, even with the cost price of the meter, will be found a considerable saving of expense.

No meters allowed but those supplied or approved of by the Company.

5% discount, on payment of £6 per annum.
10% ditto on payment of £10 ditto.

N.B.—Half a cubic foot of gas per hour will yield a light equal to a Mould candle, six to the pound.

Sell's 49th Edition.

A very live volume is the forty-ninth annual edition of Sell's Directory of Registered Telegraphic Addresses. It should prove of exceptional interest to business men who, in one volume, are enabled to secure all the information they may ordinarily require respecting over 100,000 firms in this country, compiled from official lists, together with thousands of business concerns located in other parts of the world. Postal addresses, telephone numbers, and trade descriptions, as well as telegraphic addresses, add to the utility of this bulky work of reference.

Other sections include the World's Newspaper Press with its exhaustive list of daily, weekly, and monthly periodicals classified under the names of the counties and towns in which they are respectively published; a list of the members of the London and Provincial Stock Exchanges; a long list of prominent firms in Great Britain and Ireland, each one classified under its appropriate Trade Heading being a feature of special interest to those who have something to sell to a particular trade in this country. The volume is published by Business Dictionaries, Ltd., 8 and 9, Johnson's Court, E.C. 4; price 45s.

Result of Protection.

The low-temperature carbonization industry was a most striking case of a great national industry waiting to spring into instant life upon the appearance of a small measure of protection, declared Col. W. A. Bristow, Chairman and Managing Director of Low Temperature Carbonisation, Ltd., in his Presidential Address to the Low Temperature Coal Distillers' Association of Great Britain, Ltd., at the third annual general meeting in London last Friday.

A Topical Display

Our photograph is of a recent window display in the showrooms of the Stretford and District Gas Board, carried out by the firm of John Wright & Co., Ltd. The display centred around the semi-final for the Football Association Cup, between Manchester City and Aston Villa. The main slogan at the head of the display is "Will the Villa get into Hot Water," with the answer "Yes, if the City use 'K.C.U.' Water Heaters." Cut-out figures of the two teams, carried out in the correct colours, showed the Manchester City players putting the Villa into a large bath of hot water—a prophecy confirmed by subsequent events. The background was made up of the goal posts and net, and the whole display was most attractive, in both conception and colouring. Naturally it attracted considerable attention.

Recovery of Benzole by Active Carbon*

By H. HOLLINGS and S. HAY, Gas Light and Coke Company.

Introduction.

If a gas undertaking equipped with carburetted water gas and coal gas plant decides to adopt a process of benzole extraction without alteration of the calorific value, the immediate physical consequences are either that more oil must be used for the purpose of enrichment or, alternatively, that a lower proportion of water gas must be made, which will necessitate the purchase of a larger tonnage of coal and the sale of a large tonnage of coke. The position may be stated in what appears to us to be the simplest possible way in the chart, fig. 1, which shows the relationship between the quantities of coal and oil used in the manufacture of a unit of one million c.ft. of gas of 500 B.Th.U. calorific value, and also the quantities of net coke produced after allowing for the coke used in water gas manufacture. The lowest of each of the two sets of lines represents the relationship which exists when no benzole is extracted. Thus, for example, the unit of gas may be made by using 50·5 tons of coal and 400 gallons of gas oil in which case there will be 26·5 tons of coke to be sold. Now if it is decided to extract 3 gallons of benzole per ton of coal, then it will be necessary either to purchase 600 gallons

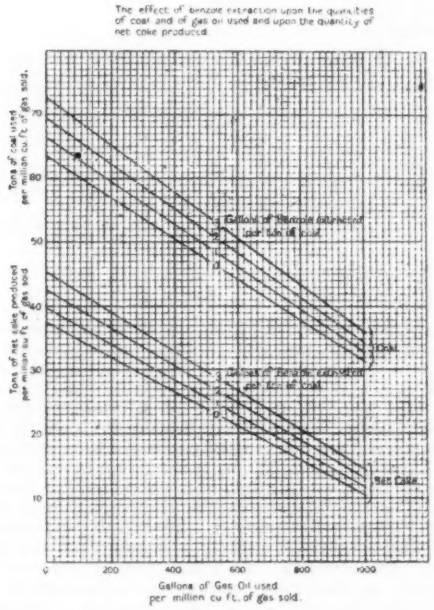


Fig. 1.

of oil instead of 400, or to purchase 58·0 tons of coal instead of 50·5 and to sell 33·0 tons instead of 26·5 tons of coke. The large increase in the coke quantity relative to the increase in the coal consumption is, of course, the result of the variation in the coal gas/water gas ratio, which is in practice necessary to maintain the standard calorific value.

The two methods of adjustment of working which have just been indicated represent the limiting effects upon the quantities of either coal and coke, or oil involved. Other values may be found within the triangles represented by an example such as that quoted, and it will be apparent also that the chart gives similar information in respect of smaller quantities of benzole to be extracted. The points on the vertical co-ordinate represent the relationships when a mixture of coal gas and blue water gas is made, which is the condition under which the greatest adjustment of coal and coke quantities becomes necessary.

It has just been assumed that we are dealing with a gas undertaking which has available carburetted water gas plant as well as carbonizing plant. In some cases it may be that carbonizing plant only is available, in which case the adoption of benzole extraction might necessitate a reduction in the declared calorific value of gas, or a reduction in the amount of steam admitted to the coal charge during carbonization. In any case, there would be more coke available for sale per unit of gas sold. Whether it is advisable for the Gas Industry to handle a large quantity or a small quantity of coke in relation to the gas which it makes will depend upon local price levels and a variety of circumstances which it is not our purpose to discuss here.

Present Position of the Oil-Washing Process.

Prior to 1929 the only commercial method for the extraction of benzole from gas was that of absorption by oil, and this method is still most widely used.

A particularly attractive feature of the oil-washing process in the case of gas-works is the ease with which it may be combined with the process of removal of naphthalene. It has often been found possible to use the whole, or a part, of an existing naphthalene washer for the simultaneous removal of both naphthalene and benzole by increasing the flow of oil and installing the necessary oil-distillation plant.

During the last few years there has been introduced a plant for the regeneration or distillation of oil which permits of the extraction of benzole equivalent to about 1·5 gallons per ton of coal, and which is attractive in certain circumstances because of its relative simplicity. With regard to the efficiency of the oil-washing process, it may be stated that from 80% to 90% of the benzole in the gas can be removed, the actual percentage being rather dependent upon atmospheric temperatures. These efficiencies are at least 5% less than that of the carbon process, as will be explained directly.

Steam Consumption.—The steam consumption in the oil-washing process depends, of course, upon the rate of oil circulation, and this in turn depends upon the efficiency of benzole extraction which is being attempted. Until recently the best steam consumption of which we had knowledge in connection with the oil-washing process was 41 lbs. per gallon of crude benzole under conditions of working such that 88% of the benzole in the gas was being extracted. Having regard to the lower steam consumption of the active carbon process, it was decided to investigate more closely the steam consumption of the oil-washing process in use at one of the stations of the Company.

In one test under winter conditions the steam consumption (exclusive of the steam required for power purposes in driving the gas washer) was reduced to 27 lbs. per gallon of benzole when the oil circulation was 7·2 gallons per 1,000 c.ft. In this case, however, the efficiency of benzole extraction was only 73%, as the conditions of operation on the plant were deliberately adjusted so as to allow the heavier constituents of normal crude benzole to accumulate in the wash oil rather than to be distilled off. At the same time, of course, the limited oil circulation permitted some of the lighter constituents to pass forward in the gas. In another test under summer conditions, the steam consumption was 31·9 lbs. per gallon of benzole when the oil circulation was 7·6 gallons per 1,000 c.ft. of gas and the extraction efficiency was 59%. The steam consumption of the active carbon process is referred to in some detail later in this paper. A general summary of the position appears to be that when a high efficiency of benzole extraction is required the steam consumption of the carbon process is definitely considerably lower than that of the oil-washing process. The steam consumption of the oil process, however, can be very considerably reduced if a sacrifice of profit-earning capacity is made by reducing the output of benzole.

The Active Carbon Process.

The early experimental work of the Gas Light and Coke Company in connection with the active carbon process and the installation of the first commercial unit by British Carbo-Union, Ltd., at Harrow has already been described by one of us in collaboration with S. Pexton and R. Chaplin (Trans. Inst. Chem. Eng., 1929, 7, 85, "Gas Journal," Vol. 188, pp. 715, 777). The plant at Harrow has continued to work satisfactorily, and the latest results obtained over a period of 12 months' working, starting with new carbon, are as follows:

The benzole yield commenced at 20% by weight of the carbon and gradually fell to about 4% after 1,500 saturations. The steam consumption started at 2·2 lbs. per lb. of benzole but steadily increased, so that the average was 3·32 lbs. per lb. of benzole or 29·2 lbs. per gallon of benzole for the whole period. The efficiency of benzole extraction varied between 93% and 95%. The carbon was replaced at

* From a paper before a Joint Meeting of the London Section and the Chemical Engineering Group of the Society of Chemical Industry, Feb. 5.

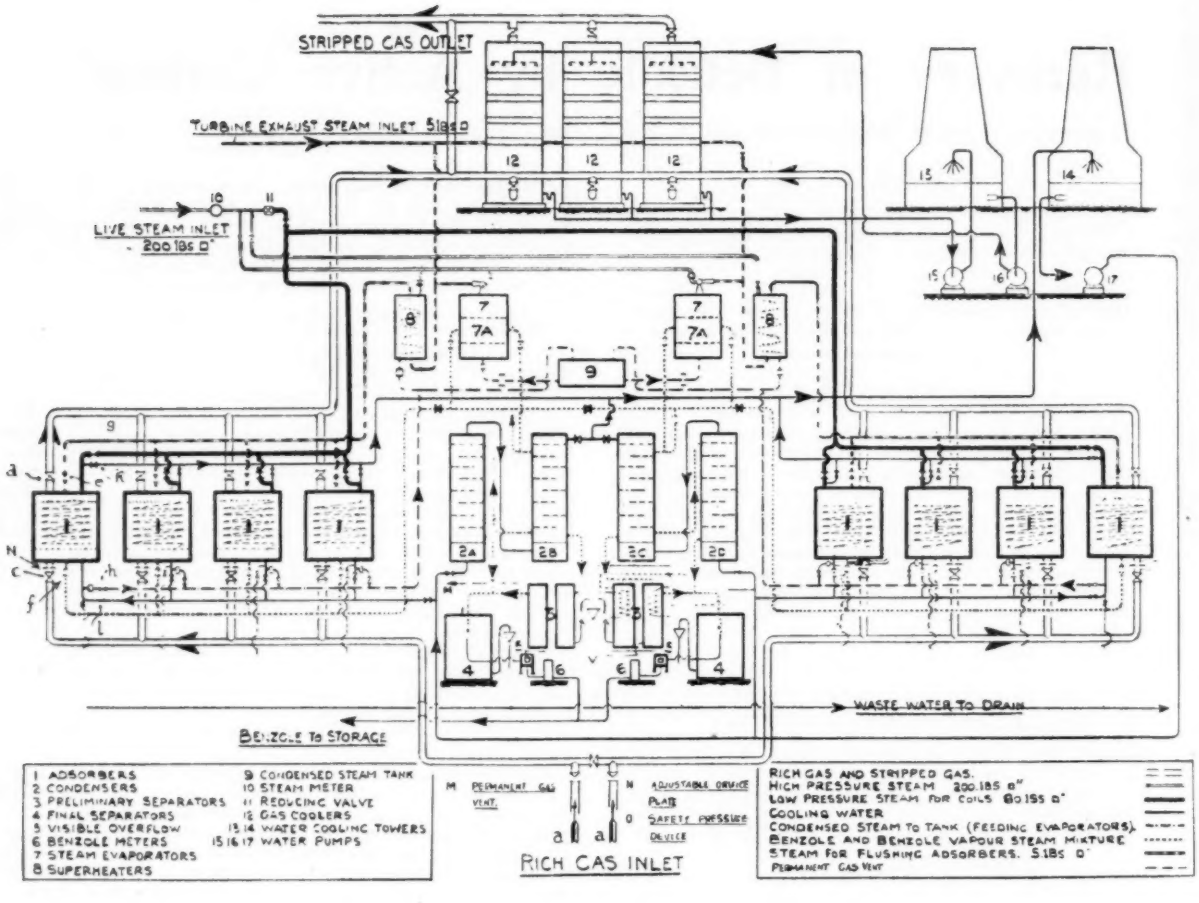

STRIPPED GAS OUTLET
TURBINE EXHAUST STEAM INLET 5 lbs G
LIVE STEAM INLET 200 lbs G
WASTE WATER TO DRAIN
BENZOLE TO STORAGE
RICH GAS INLET
1 ADSORBERS
2 CONDENSERS
3 PRELIMINARY SEPARATORS
4 FINAL SEPARATORS
5 VISIBLE OVERFLOW
6 BENZOLE METERS
7 STEAM EVAPORATORS
8 SUPERHEATERS
9 CONDENSED STEAM TANK
10 STEAM METER
11 REDUCING VALVE
12 GAS COOLERS
13 14 WATER COOLING TOWERS
15 16 17 WATER PUMPS
M PERMANENT GAS VENT
N ADJUSTABLE ORIFICE PLATE
O SAFETY PRESSURE DEVICE
RICH GAS AND STRIPPED GAS.
HIGH PRESSURE STEAM 200 lbs G"
LOW PRESSURE STEAM FOR COILS 80 lbs G"
COOLING WATER
CONDENSED STEAM TO TANK (FEEDING EVAPORATORS).
BENZOLE AND BENZOLE VAPOUR STEAM MIXTURE
STEAM FOR FLUSHING ADSORBERS. 5 lbs G"
PERMANENT GAS VENT

FIG. 2.

the end of this period of working, so that the equivalent consumption of carbon was 6·8 lbs. per 1,000 lbs. of benzole.

The Beckton Plant.—This installation deals with gas from horizontal retorts and coke ovens and is capable of producing 20,000 gallons of benzole in 24 hours from 75 million c.ft. of coal gas containing 2·9 gallons per 10,000 c.ft. when operating at an efficiency of 92·5%. The plant was constructed by the British Carbo-Union, Ltd., and has been in operation since August, 1932.

It is generally agreed that the previous removal of impurities in the gas, in particular tar and hydrogen sulphide, is essential to this process and, therefore, only purified gas, free from naphthalene and associated unsaturated hydrocarbons, is treated. The plant is therefore placed at the outlet of the naphthalene washers into which all purified and metered coal gas streams converge.

The plant is housed in a three-storey building executed in ferro-concrete. An annexe contains the laboratory, office, lobby, and staircase. A flat roof carries a dormer, which, together with louvres fitted in the walls of the lower part of the building, provide adequate ventilation. The large windows fitted in the façade and back of the building admit plenty of light which at night is supplied by electric incandescent lamps mounted in explosion-proof fittings.

The lay-out of the plant is shown diagrammatically in fig. 2. It is arranged in two halves in such a way that both can be operated as one unit or independently of each other. Each half has a separate gas inlet main, controlled by valves and contains four adsorbers, each holding about 7 tons of active carbon. The adsorbers are cylindrical vessels, 9 ft. in diameter and 27 ft. in length, containing pipe coils for cooling and heating purposes and carbon supporting grids, which being hinged from the adsorber shell can be lowered in the centre for the purpose of discharging the carbon. The other sections of the plant are also arranged as two individual units and comprise two steam regenerators, two sets of tubular condensers, two sets of preliminary separators, two final separators, and two benzole meters. An underground installation of eight tanks provides storage for 100,000 gallons of spirit. Three gas coolers, adjacent to the plant, cool stripped gas by direct contact with water and condense the water vapour which has been taken up by the gas in passage through the steamed adsorbers. The water requirements for cooling purposes are supplied by two sets of electrically-driven centrifugal pumps and two cooling towers. One circuit supplies the needs of the gas coolers while the other is available for a battery of rack coolers, the benzole condensers, and the cooling coils in the preliminary separators. The rack coolers are part of the closed cooling system, which has just been introduced to minimize corrosion in the adsorber coils. Previously this was serious on account of differential oxygen and salt concentration of the cooling water and the condensed steam introduced into the coils during the desorption process. The closed system is filled with condensed steam which is de-aerated so that no corrosion can arise from the causes mentioned.

Operation of Plant.—The quantity of gas to be passed through any adsorber can be varied within relatively wide limits, the range being one-third to one million c.ft. per hour. The number of adsorbers at work is governed by the throughput and the adsorptive capacity of the carbon, which in turn depends on the age of the carbon. As it is neither practicable nor desirable to have carbon of the same age in all adsorbers, their capacity differs materially. This can be allowed for in plant operations either by varying the adsorption period of individual adsorbers or by adjusting the respective gas throughputs in inverse ratio to the adsorptive capacity of the carbon. When two or three adsorbers are at work, the first alternative is possible, but with a larger number, the second alternative is adopted in order to maintain a uniform operating programme and to prevent unnecessary overlapping of the different cycles.

The Adsorption Process.—When the plant is working at full capacity, five adsorbers are under gas, two are being steamed, while one adsorber is held in reserve or is being recharged with carbon. Adsorption of benzole continues, until the "break point" is reached. This is ascertained by observation of flat flame burners (Bray's bat's-wing No. 4), which are installed at the laboratory and connected to the individual outlets of the adsorbers as well as to the common outlet of the plant. The burners are very sensitive and indicate the presence of 0·03 to 0·05 gallon of benzole per 10,000 c.ft. of gas by the appearance of a fringe of luminous gases over a black line.

The Adsorption Process.—When the adsorber is saturated with benzole it is taken off the line, after another adsorber, freshly steamed, has been put into its place. Cooling water

is shut off, and indirect and direct steam are admitted at the same time.

The Steam Supply.—The process steam is obtained from three sources, viz.: (1) Live, superheated steam; (2) low-pressure steam from the steam regenerators; (3) exhaust steam from a turbo-blower installation. Live steam is taken from the works mains at 200 lbs. per sq. in. and 250° C. The steam used in the coils ("indirect steam") is a relatively small proportion of the total and amounts to 1,000 lbs. per cycle. It is reduced to 80 lbs. and desuperheated. Direct steam is required to the amount of about 10,500 lbs. per cycle. Part of this is supplied by steam regenerators whose function is to raise steam at the expense of the latent and sensible heat of the distillation vapours.

The design of the regenerators is shown diagrammatically in fig. 3. The distillation vapours coming from the adsorbers pass round a nest of tubes between two header plates, and thence to the condensers. Since the temperature of the distillation vapours is mostly below 100° C., a partial vacuum is necessary in the chamber and is produced by the action of a steam ejector situated at the top. As a consequence, the boiling-point of the water in the tubes is lowered to such an extent that heat can be transferred from the condensing distillation vapours to the boiling water. The steam evolved is entrained by the high-pressure steam in the ejector and compressed to the working pressure of 2-3 lbs. per sq. in. The supply of feed water, consisting of condensed steam from the adsorber coils and softened water from outside sources is controlled by an automatic float valve.

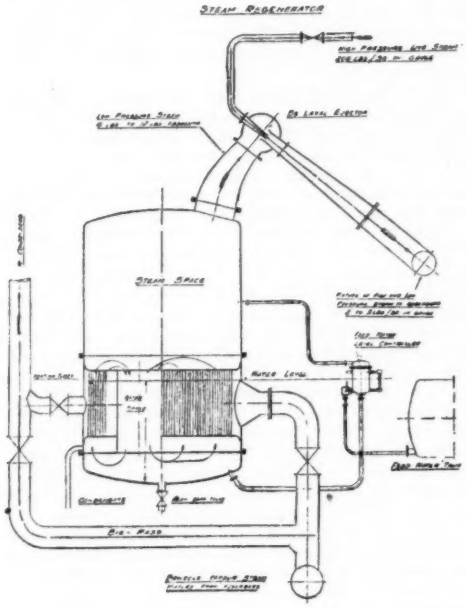


Fig. 3.

The two regenerators installed on the plant are capable of supplying 4,500 lbs. of steam per cycle which together with the live steam used on the ejectors (6,000 lbs. per cycle) covers the requirements of direct steam, when one adsorber is steamed at a time. When two adsorbers are steamed simultaneously, additional direct steam is required. This is taken from a turbo-blower installation situated in the vicinity of the plant.

The consumption of process steam is affected so slightly by variations in the adsorptive capacity of the carbon that it is practically a constant per cycle of operation. About 6% of the total heat requirements of the process is accounted for by the latent and sensible heat of the benzole; the rest is used to raise the temperature of the adsorbers and their contents or in the form of scavenger steam. Only after the adsorptive capacity of the carbon has fallen to about 10% can a reduction be effected in steaming time and steam consumption.

Gas boosters are not essential to the active carbon plant, and it should be noted that they do not exist at Harrow. The Beckton plant was installed at a time when reorganization of naphthalene washers and gasholders was in progress. A boosting plant was essential for these modifications, and in the design of the benzole plant consideration had to be given to the choice of lower capital cost and higher pressure loss through the adsorbers, or higher capital cost and lower pressure loss. Under the peculiar conditions existing at Beckton, it was found to be more economical to install fewer adsorbers with gas boosters.

Plant and Process Results.—The annual production of benzole of the Beckton plant at the present time is about 3 million gallons, corresponding to an extraction of 2·25 gallons of benzole per 10,000 c.ft. of gas equivalent to a yield of 3·1 gallons per ton of coal. When the works produces its full output of gas the annual production will be 4½ million gallons. An extraction efficiency of over 92% is usually maintained, but for a short time this has fallen below 90%, owing to conditions arising from the corrosion of the coils as already explained. It is a little difficult to give a final figure respecting the consumption of steam on the plant, owing to the various slight irregularities from normal routine which are inseparable from the starting up of a plant of this magnitude. However, during one long unbroken run with about half the plant a total steam consumption of 30 lbs. per gallon of benzole was recorded. At the same time the rate of carbon replacement was 5·7 lbs. per 1,000 lbs. of benzole.

The average over-all steam consumption, inclusive of all losses due to irregularities, has been 36·6 lbs. per gallon and at the same time the average rate of carbon replacement has been 7·1 lbs. per 1,000 lbs. After the experience which we have now had we see no reason why in future the average results should not be equivalent to the better of the two results which we have quoted. It will be noted that by comparison with the results at Harrow the carbon consumption has been slightly decreased, but the total steam consumption has been slightly increased.

Sulphur Removal during Benzole Extraction.

All gas undertakings are under a statutory obligation to remove the whole of the hydrogen sulphide from gas before distribution to the public. Although there is no legal restriction upon the proportion of other sulphur compounds, such as carbon disulphide and thiophene, which may be distributed with the gas, it is becoming increasingly apparent that the removal of these compounds from gas is very desirable in order to eliminate the corrosive action of the products of combustion upon gas-burning appliances and in order to extend also the field of usefulness of such appliances. Considerable importance is attached, therefore, to the circumstance that these sulphur compounds are extracted simultaneously with the extraction of benzole.

The vapour pressure of thiophene has not been determined, but the close analogies which it exhibits with benzene in all its properties and the fact that its boiling point is only 5° C. higher, make it reasonable to predict that at normal temperatures its vapour pressure will be very slightly lower than that of benzene. A circulation of solvent in the ratio which suffices for the absorption of benzene in the oil washing process will therefore remove simultaneously and with equal or slightly greater efficiency all the thiophene and its higher boiling homologues. At temperatures near 20° C. = 68° F. this ratio may be taken as 8 gallons of solvent (gas oil) per 1,000 c.ft. of gas.

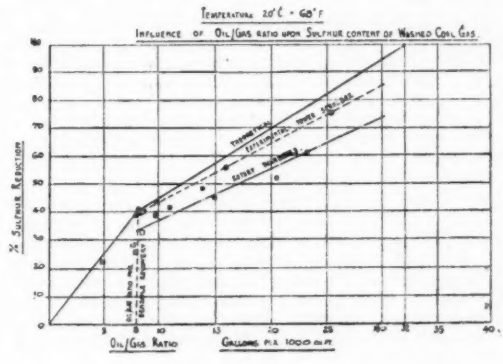

Temperature 20° C = 68° F
Influence of Oil/Gas ratio upon Sulphur content of Washed Coal Gas
% Sulphur Reduction
Oil/Gas Ratio
Gallons per 1000 cu ft

Fig. 4.

The vapour pressure of carbon disulphide at 20° C. is 300 mm., and that of benzene is 75 mm., so that the minimum oil-gas ratio for the complete extraction of carbon disulphide is 32 gallons per 1,000 c.ft. If the oil-gas ratio is 8 gallons per 1,000 c.ft., then only one-quarter of the carbon disulphide, representing 20% of the total sulphur in the gas, will be adsorbed. The maximum over-all reduction in sulphur content of the gas at an oil-gas ratio of 8 gallons per 1,000 c.ft. is therefore 40%, of which half represents the complete absorption of the thiophene group and the remaining half represents one-quarter of the carbon disulphide. Absorption should be complete at an oil-gas ratio of 32 gallons per 1,000 c.ft.

In fig. 4 the continuous curve shows these results deduced

from theoretical considerations, while the broken lines show results obtained by actual washing in an experimental tower scrubber and in rotary washers used for benzole recovery. It is seen that by circulating quite a moderate quantity of oil in a benzole extraction plant the sulphur content of the gas may be reduced by nearly 40%.

The active carbon process is much more efficient than the oil-washing process in respect of removal of sulphur from gas. In the early part of the absorption period practically the whole of both the thiophene and the carbon disulphide are removed, but as saturation of the carbon is approached the more volatile compounds are displaced. The results of a series of tests made upon the gas issuing from one of the units of the Harrow active carbon plant are shown in fig. 5.

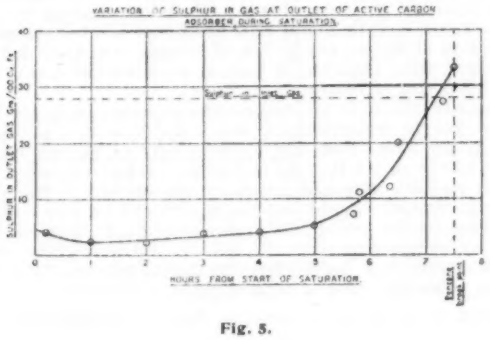


Fig. 5.

During this test the inlet gas contained 28 grains of sulphur per 100 c.ft. As will be noted nearly all this was removed during the first five hours, but towards the end of the run the sulphur content at the outlet rose sharply, and finally just exceeded that at the inlet. The average sulphur content of the treated gas for the whole period was 7·0 grains per 100 c.ft., giving an extraction efficiency of 75%.

On the Beckton plant the over-all efficiency is a little higher. Over a period of six months' continuous working the sulphur content of the gas was 30·5 grains at the inlet and 6·1 grains at the outlet, giving an extraction efficiency of 80%. This result will compare favourably with the efficiency of processes which have been devised specifically for the removal of sulphur compounds, although the treated gas was mixed with carburetted water gas which raised the sulphur content of the mixture to 8·3 grains per 100 c.ft.

Quality of Benzole.

It is generally recognized that the quality of crude benzole depends very largely upon the conditions of carbonization. Generally speaking when the products of carbonization escape from the gas retort or oven without having been submitted to fairly drastic secondary thermal decomposition, the crude benzole recovered contains a relatively high proportion of paraffins and also of unsaturated hydrocarbons. The benzole recovered from gas made in a lightly filled horizontal retort contains less unsaturated and paraffinic hydrocarbons than does that recovered from gas made in continuously operated vertical retorts or in completely filled intermittent vertical retorts. So far as the paraffins are concerned, it may be claimed that these are no detriment when the production of motor spirit is the objective, except in so far as they tend to reduce the anti-knock value of the benzole and so reduce the proportion of petrol which may be blended with it. Any high proportion of unsaturated hydrocarbons is a serious source of loss when the acid-washing processes of refining are in use. With the adoption of the inhibitor process, and under the provisions of the most recent specifications for motor benzole, then it is clear that these unsaturated hydrocarbons may be in fact desirable because of their high anti-knock value.

A consideration of the relative advantages and disadvantages of carbon recovered crude benzole, as compared with oil recovered crude benzole, necessitates drawing attention to the recent marked change in refining conditions. Until January, 1933, the whole of the benzole placed on the market both for chemical purposes and as a motor fuel was refined by means of a sulphuric acid wash, and hence practically the whole of the unsaturated hydrocarbons were removed. Commencing in January, 1933, benzole for use as a motor spirit has been accepted under a modified specification, which admits of the useful unsaturated hydrocarbons being saved.

When the old process of refining by acid washing was in use the limitation of sulphur in motor benzole gave rise to no difficulty, because thiophene and similar compounds were removed by the acid wash. Since the inhibitor process was adopted, however, there is more difficulty in keeping within the limit for sulphur, because the only means of reducing the sulphur content of the benzole is to remove the carbon disulphide by distillation. Hence, most refiners have had to refine a certain amount of their benzole by acid for the purpose of blending with the inhibited benzole. It has already been pointed out that the oil-washing process is less efficient than the carbon process in the removal of sulphur compounds from the gas. It follows that the benzole recovered by means of active carbon contains more sulphur than does that recovered by means of oil.

An oil-recovered benzole will normally contain 0·25%-0·4% of sulphur as carbon disulphide with 0·3%-0·5% of sulphur in other forms. A carbon-recovered benzole, on the other hand, may contain 0·7%-1·35% of sulphur as CS_2 with 0·45%-0·55% of other sulphur, depending on the efficiency at which the process is being run. In order to get down to the 0·4% sulphur limit demanded by the National Benzole Specification on the product from the carbon-recovered benzole, it is therefore necessary to remove not only carbon disulphide, but some portion of the other sulphur compounds.

The crude benzoles recovered in some of the older oil-washing plants contained considerable quantities of wash oil, carried over with the benzole during distillation. The wash oil found in the crude benzole may amount to from 12% to 15%, and such crude benzoles require a separate distillation before they may be recovered as a suitable raw material for the subsequent refining or inhibiting treatment. On the other hand, the crude benzoles recovered by either the more modern oil-washing processes or the active carbon process are suitable for direct treatment, and hence one distillation is saved. Such crude benzoles can be converted to inhibited benzole in one distillation which includes the removal of the forerunnings and the traces of pre-formed gums and heavy solvent that may be present.

If the quality of the crude benzole recovered by carbon is judged by the simple laboratory distillation test carried out in a side-arm flask, it is found that when the recovery is 3·1 gallons of crude benzole per ton of coal, about 93% of that benzole distils below 120° C. Our experience of the oil-washing process indicates that either the yield of crude benzole per ton of coal is much less than the yield we have just quoted, or the proportion of distillate below 120° C. is much less. On that portion of the benzole which has to be acid-refined the losses are heavier with a carbon-recovered benzole than with an oil-recovered benzole from a similar gas. This is due to the presence of an increased percentage of unsaturated hydrocarbons distilling mainly below 80° C., and is one result of the higher efficiency of the carbon in stripping the gas. It is probably true that with a special plant these may be removed by re-distillation before the product is submitted to the acid-refining process.

We desire to express our thanks to the Directors of the Gas Light and Coke Company for permission to publish this paper, and also to several of our colleagues for assistance in the preparation of it. We are particularly indebted to Dr. G. W. Anderson, who is in immediate charge of the operation of that section of the Beckton Works which includes the benzole-extraction plant.

Discussion.

Mr. W. J. A. Butterfield said he had been particularly struck by the figures relating to sulphur elimination with the carbon process in comparison with the oil washing process, and there was no doubt of the advantage of eliminating as much sulphur as possible from gas in view of its effects on gas-using appliances. In 1920 their legislators, in a Private Bill promoted by another London Company, evaluated the removal of sulphur to the extent referred to in the paper, and it was decided that the consumer might be charged ¼d. more per 1,000 c.ft. for the extraction of sulphur to the extent which the authors now stated they were doing without any additional charge to the consumer. The profits on the benzole extraction process gave the consumer the benefit of the reduced sulphur content. He imagined, however, that the Gas Light and Coke Company took that ¼d. per 1,000 c.ft. into the balance-sheet of the benzole recovery as a credit.

The only other point that occurred to him as deserving of comment from the sulphur point of view was the reference to the limit of 0·4% sulphur in motor benzole. He had the impression that this figure was decided upon out of regard to what the benzole extraction processes then in being were capable of effecting. At the same time, he did not think it had been determined on any adequate evidence that a larger proportion was harmful to the cylinders of motor-car engines. Some years previously the Admiralty fixed a limit of something like 0·5% for the sulphur in fuel oil. Then came along a source of supply of cheap fuel oil in which the sulphur was nearly as much as 3%, and in order to take advantage of that cheaper supply the Admiralty raised the limit of permissible sulphur in fuel oil to 3%. So far, said Mr. Butterfield, he had not heard that any harm had come to the tubes of boilers as a result. Personally he very much doubted if, in order to take advantage of the process that had been described, the permissible limit of sulphur in motor benzole was raised to 0·7% or 0·8%,

anyone would be any the worse off, but perhaps on that point others could speak with greater authority than he.

Careful Experimental Work.

Mr. F. M. Potter said his interest in the process described in the paper dated from 1924, when he went over to Germany with Mr. Hoffert, of the National Benzole Company, to examine the initial plant that had been laid down there. At that time he had been able to report that the process was working successfully on the recovery of such solvents as alcohol, ether, &c., but that the plants working on either coke oven gas or town gas gave rise to some doubts as to the real commercial value of this process. It had been possible to determine the general figures, but it was not possible to arrive at any conclusion, particularly with regard to the life of the carbon. The maximum cycle life of the carbon then was something over 100, and it was recommended that the only way to obtain more evidence was to put a plant down in this country. That was done at Harrow by the Gas Light and Coke Company, and it was on the basis of the very careful work which had been carried out there under the supervision of Mr. Hollings that the decision was taken to lay down a very much larger plant at Beckton. It was perhaps interesting to know that Beckton was working on cycles of from 1,200 to 1,300 and Harrow on 1,500, and that had been due to the very careful experimental work that had been carried out. There had been a very careful governing of the steam conditions in the filters in order to obtain that life and prevent depreciation of the filter by gum formation.

As a matter of fact, continued Mr. Potter, when the plant started up it involved those engaged on benzole refining in an unexpected problem that was never foreseen in the early stages of the examination of the plant in Germany, because at Beckton the plant was operated at a very much higher efficiency than was the case with the German plant, and not only were the benzole hydrocarbons removed, but also the carbon bisulphide, as had been explained, accompanied by the light saturated and unsaturated hydrocarbons, boiling mainly between 40° and 65°. That process came along at about the same time as the inhibitor process. They were no longer removing the thiophene content of benzole by the acid refining process, and they were up against the problem of removing from the benzole the carbon bisulphide which had been so efficiently removed from the gas. That had given rise to the necessity for a new orientation of ideas on benzole refining, work which at the present time had not yet reached its conclusion. At the present moment most people had to indulge in partial acid refining to reduce the sulphur and secure a sufficient removal of carbon bisulphide as they know how by the existing plant, but the new procedure which would come into use in the very near future would permit of the careful removal of the light hydrocarbons with their accompanying carbon bisulphide, and the removal of that carbon bisulphide by one or other of the chemical processes now under examination. Mr. Hoffert had personally developed one process for the removal of carbon bisulphide by chemical means.

It was interesting to know that where this plant had been put into smaller works on the Continent it had been found possible to use the carbon benzole direct as a motor fuel. That motor fuel in Germany had about 0·5% sulphur, whereas in this country the carbon benzole from Durham coal contained 1·4% sulphur, and although there was no direct evidence what the real limit of sulphur might usefully be, he did not think the benzole industry would consider going backwards on the 0·4% even if it might be considered safe. The figure of 0·4% was at present approved, and the efforts of the refiners would be to maintain that figure by the adoption of these new processes.

Motor Exhaust.

Mr. E. G. Hancock, who deputised for Mr. W. H. Hoffert and apologized for his absence through indisposition, said that work was being done on a process for the removal of carbon bisulphide, but it was rather premature yet to give any details. In regard to the 0·4% total sulphur specification, one of the very important points was that sulphur in motor fuel was very largely converted into hydrogen sulphide in the exhaust, and this naturally caused an unpleasant smell when starting-up and using a rich mixture. That was one of the reasons why a high content of sulphur in motor fuel must be avoided.

Benzole for the Dyestuffs Industry.

Prof. G. T. Morgan, F.R.S., said he supposed one upshot of this work with benzole would be to give an increasingly plentiful supply, and as a member of the two Statutory Committees under the Dyestuffs Import Regulations Act, he could only hope that the profits accruing to those who carried out these processes would enable the producers of benzole before long to supply the small quantity required by colour manufacturers less the 8d. excise tax. This tax was really a very serious impediment to the development of the dyestuffs industry in this country. As the result of the Dyestuffs Act, an industry had been built up which did not exist before, but now it was being somewhat handicapped by the fact that the manufacturers, who were using a very small percentage of the total benzine used in this country, had to pay a tax which made a difference of 1d. per lb., and it was placing the industry in a position of enormous risk, in spite of the fact that there was an import duty on coal tar intermediates. The development of the dyestuffs industry in this country had now been going on for about 14 years and the intermediates had been made in this country, but if they went back to imports again they should be as dependent on the foreign producer as they were before 1914.

Hydrogenation of Benzole.

Dr. J. G. King said that some time ago attempts were made on the Continent to introduce hydrogenation as a means of refining benzole. That process was similar to the other hydrogenation process with tar, but the action was not allowed to go so far. The sulphur compounds were converted almost entirely into H_2S and liberated as such, and by these means it was possible to convert crude benzole into refined benzole which was stable; it would not stand the sulphuric acid test, but it would stand a reasonable storage test. The yield was over 99% of benzole, and the most encouraging results averaged 89% by acid washing. At the Fuel Research Station experiments had been going on in connection with the recovery of spirits by means of active charcoal, attention being chiefly directed towards the treatment of low-temperature gases. The plant was admittedly a small one and could not be spoken of in the same breath as the Beckton plant. It had been found that by operating the plant not to a definite break point but to a time cycle—which unfortunately used more steam—it had been possible to increase the yield considerably. Admittedly this increase was only effected at the expense of a certain amount of steam, although only a commercially minded person could work out what the difference was. At any rate, it was not possible to work out the difference at present on the scale on which the experiments were being carried out, but the differences in yields were as great, on one cycle, as from 2·1 gallons to 3·6 gallons. This referred, however, not to low-temperature gas but to gas obtained from horizontal gas retorts. That maximum figure of 3·6 compared with the 3·1 mentioned by Mr. Hollings.

Another point upon which he desired to comment was the removal of sulphur. In some earlier work described in a technical paper by the Fuel Research Board the removal of sulphur compounds from water gas was discussed. It was there shown that it was possible to remove the sulphur compounds until the concentration of sulphur in the gas was as low as 0·5 grain per 100 c.ft. He believed Mr. Hollings had mentioned 4 or 5 grains with coal gas. The interesting side of this work, however, was connected with the re-activation of the carbon. It had been found that if the carbon was re-activated with steam and air, a certain re-activation was obtained and a carbon produced which had a certain reaction velocity in the further absorption of sulphur. When, however, a small proportion of ammonia was added to the mixture of steam and air, the amount of air added was sufficient to bring the oxygen concentration up to 1% and the ammonia was sufficient to bring the ammonia concentration up to 0·5%. It was found that by doing this it was possible to re-activate the carbon and remove the sulphur from the charcoal. It also increased the reaction velocity of the particular charcoal for the absorption of sulphur afterwards, and he suggested that this idea was worth the attention of the Gas Light and Coke Company.

Stripping Vertical Retort Gas.

Dr. W. R. Ormandy, who also expressed appreciation of the manner in which the Gas Light and Coke Company had not only introduced a new development but had given the benefit of the results to the Industry at large, asked whether the authors knew anything about the use of tetrahydronaphthalene in place of oil for washing out benzole. At the same time, it would have been better had the authors stated a little more definitely what they meant by the word "benzole." If it was motor benzole and the product was within the limits laid down by the National Benzole Association, then they knew where they were. Unless that statement was made, the benzole might finish with xylene and might even go a good deal further.

A point of some interest was to know how the adsorption plant would work with vertical retort gas. These generally contained considerable amounts of straight paraffins as well as unsaturated paraffins, and as the carbon acted by adsorption and was affected by the double link, what happened to the straight chain paraffins? Did they escape or were they taken up by the charcoal on its way through, because the paraffins had a considerable amount of naphthalene?

With regard to sulphur, he had been interested in sulphur in motor fuels for some time, and a story which had been told him by the late Mr. Herbert Robinson, of the Midland Tar Products Company, illustrated the effect of sulphur. During the war Mr. Robinson lived 20 or 30 miles from where he worked, and went backwards and forwards by car each day. Although he was working for the Government, however, he could not get permission to use the benzole which he was producing for the War Office. However, they allowed him to use the fore-runnings, which contained 50% of carbon bisulphide; and for two years Mr. Robinson ran a six-cylinder 20-h.p. Delage car on a mixture of fore-runnings containing 50% carbon bisulphide without any detriment to the engine, the only point being that he had had to have three silencers put in. In other words, the fact was that with an ordinary engine with a reasonable amount of warmth round the cylinder, it did not matter how much sulphur there was so long as there was no free elementary sulphur. The real corrosive element in motor spirit was the free elementary sulphur. There was none in natural oils, and he very much doubted whether there was in any benzole as it was driven off the adsorbers; but the practice was to act on the material by sulphuric acid, and by that means make H_2S and SO_2 which reacted to give sulphur which was the corrosive, so that the work done in purification resulted

in the formation of the very thing which was the greatest danger.

The Carbon Process for Small Works.

Mr. H. Griffiths, who said he entered the discussion primarily as a member of the staff of British Carbo-Union, Ltd., added that with regard to benzole recovery it was rather difficult to explain really how to calculate the cost. One of the most interesting things in the paper was the graphical method whereby the variables could be calculated. Continuing, Mr. Griffiths said that the activated carbon process as a whole must be considered in its relation to the Gas Industry and not merely as a benzole extraction process. It had been stated by the authors that the process purified the gas in a manner which would compare favourably with the efficiency of processes which had been devised specifically for the removal of sulphur compounds. That must be admitted, but it should not be forgotten that the active carbon served to remove many other things from the gas. The carbon adsorption process would, in fact, remove practically everything that existed in the gas with a local temperature above the ordinary atmospheric temperature. The higher the molecular weight the more completely and the more easily would the removal be. Naphthalene, therefore, was completely removed, ammonia was removed, and so were any traces of sulphuretted hydrogen that might have been left by the ordinary purifier, and so on. While in the case of very large plants such as the one at Beckton a certain amount of diffidence might be felt in proceeding without naphthalene removal plant, the carbon process in the case of small plants could be relied upon completely to remove the naphthalene. Sulphuretted hydrogen was also removed. It had been known for a long time that sulphuretted hydrogen could be removed by catalysis, particularly in the presence of traces of ammonia, and he had had the advantage of seeing a very large plant at Oppau where this was done.

A further feature of the carbon process of importance was that the cost of recovery was almost independent of the efficiency of extraction. In other words, if the efficiency was pushed up it did not mean that the steam consumption increased tremendously or that the quantities of material to be handled increased enormously. This applied to solvent extracts in which the very high adsorptive power of the carbon introduced a flattening of the cost/yield curve.

On the subject of carbon consumption, continued Mr. Griffiths, it was perfectly true that in 1924 and 1925, when the process was first exploited, this was very high. Since that time, however, there had been a steady development of the physical and chemical factors involved, and this had enabled reductions to be made until they got such figures as had been mentioned in the paper. Moreover, they must not overlook that there were not only the chemical and physical factors to be borne in mind. There was one very important factor, and that was the gradual change which it had been possible to bring about in the quality of the carbon used. That factor was known as the retentivity of the carbon, which influenced the chemical capacity of the carbon as a catalyst. It was only by gradual improvement in this respect that the figures mentioned in the paper had been made possible.

Among the interesting features of the Beckton plant was the fact that the thermal balance had been carefully studied, and it could be seen that those responsible for the plant had gone so far as to adopt the principle of the reverse heat engine in the mixer system, in which mechanical work was used to raise the temperature of the supply of low-pressure vapour. The impression might be gained from a reading of the paper that this active carbon process required complicated and costly plant, but it was the fact that plants had been constructed for outputs suitable for works manufacturing even as low as 1,000,000 c.ft. of gas per day and less. The Beckton plant was the largest in the world, and it was one in which his Company naturally took a great pride. In conclusion, Mr. Griffiths said that, while it was not his privilege to express thanks to the authors, he must say that his Company realized only too well the enormous amount of work that had been done by Messrs. Hollings and Hay, and were very grateful both to the authors and also to the Gas Light and Coke Company for having the work carried out and permitting the results to be published.

Mr. W. A. S. Calder referred to the regeneration of the carbon and inquired whether the spent active carbon that had been removed from the vessels was used or whether by some process of calcination it could be regenerated.

"A Lasting Process."

Dr. R. Lessing referred to the distribution of the adsorbed hydrocarbons, and said it would be interesting to know what was the concentration of carbon, in the different parts of the adsorber from the bottom to the top, in the adsorbed product. This, he said, reminded him of some work that he did during the war when he put up a plant which, in engineering principles, was identically the same as that described, but in execution it was very different. This particular work involved the recovery of toluene from gas, and benzole played a very minor part. The difficulty arose in obtaining sufficient supplies, particularly from those gas-works which could not afford and did not have facilities for installing plant of the routine character for extracting benzole and toluole from the gas. What was done then was to try to support the oil to be used in the extraction on a solid sub-strata. For this purpose charcoal and broken kieselguhr was used soaked in oil, and it was placed in the purifier boxes, four purifier boxes being used very much after the manner of the adsorbers in the Beckton plant. The process was otherwise the same. The gas passed through the mass from the bottom up, and the steam passed downwards. There was a very much higher concentration of the adsorbing material—it was not exactly an adsorbing process—in the lower part at the gas entry side, and conditions had to be in balance so that by the time the poorer portion from the top became sufficiently saturated to allow some of the benzole to slip past, the box had to be shut off and steamed out. It would be interesting to know to what extent the break-point in the adsorption curve influenced the run with the process described in the paper. Dr. Lessing expressed the view that, generally, the paper indicated a step forward to what was bound to be a lasting process for gas-works purposes.

Dr. G. E. Foxwell pointed out that no mention of costs had been made in the paper, but it seemed to him that the whole future of this process would depend upon costs.

Reply by Mr. Hollings.

Mr. Hollings, replying first to Dr. Foxwell on the question of cost, said it was very difficult to generalize and make comparisons of costs between the different processes, because so much depended on a variety of local circumstances such as the sizes of plant, cost of steam, efficiency desired, and so on. Therefore, it was felt that the paper gave the essential technical facts in studying the steam consumption and the carbon.

Mr. Hay mentioned that the cost of labour worked out at 0·14d. per gallon.

Mr. Hollings, replying to Dr. Lessing, with regard to the distribution curve, said there had been a number of publications dealing with that. The curve took a very sharp bend at the end, and there were a number of these distribution curves in the literature with regard to benzole and various carbons. The break-point was really very sharp.

As to whether the spent carbon was really waste material, that was by no means necessarily so, because there were processes of regeneration which were being investigated at the present time. Fairly large quantities of regenerated material had been used on the Harrow plant, but they had not yet arrived at a sufficient degree of finality to come to a decision respecting the Beckton Works with regard to this. Regenerated material did not have quite the same adsorptive capacity as the original material, but it was cheaper.

Dr. Ormandy: How much is reduced to powder?

Mr. Hollings: I should say from 15 to 20%.

Dr. Ormandy: That is an important item.

Mr. Hollings, continuing, agreed, and dealing with Dr. Ormandy's request for a definition of benzole, said that when he spoke of benzole in connection with gas-works recovery plant, he meant that part of the gas which could be extracted by active carbon under conditions which enabled a high efficiency of extraction to be relied upon and anything which could be so extracted and condensed was called benzole. That would be quite clear to anyone operating any of these processes, and the analytical process was fairly well established in connection with the control of the oil washing process. Vertical retort benzole, using the word "benzole" as he had defined it, was adsorbed by active carbon and the yield might be higher than from horizontal retorts, but it contained a higher proportion of paraffins. The paper contained a reference to a detailed study of that side of the matter by one of his colleagues, Mr. Ross, results of which were published in the Journal of the Society a few years ago.

As to whether sulphur caused any complication in the working of the plant, as mentioned by Dr. King, it was fair to say that the gas-works did not worry about sulphur; it was all passed on in the benzole to the benzole refinery. Thus, sulphur caused no trouble so far as the gas-works extraction end was concerned. What was the more serious source of trouble and caused the fouling, was the polymerization of the unsaturated bodies in contact with the carbon, causing an accumulation of gum. As the carbon fouled during the 1,200 to 1,400 cycles which had been referred to, there was an accumulation of gum to the extent of 25 to 30% by weight, and that was a very serious source of trouble so far as the extraction process was concerned. Dr. King's reference to the higher extraction efficiency and higher sulphur removal which could be obtained when using different cycles was, of course, of very great interest, but, as Dr. King himself had pointed out, it was necessary to balance the results always against the higher steam consumption necessarily involved in such cases.

Referring to the progress which has been made since Mr. Potter first saw this process in operation on the Continent, Mr. Hollings mentioned that the direction of the flow of gas had been reversed relative to the direction of the flow of steam, and that was probably one of the most important of the various changes that had been made, in so far as that affected the life of the carbon, because the steam was put on to the carbon bed in a direction contrary to the flow of the gas, and there was far less tendency for unsaturated hydrocarbons to penetrate far into the carbon bed. They were being driven back and given the minimum opportunity to polymerize while in contact with the carbon. Finally, Mr. Hollings referred to Mr. Butterfield's comments, and said that there was no doubt that the value of the sulphur removal in the process represented a very definite value to the gas consumer, and therefore to the gas undertaking, but it was one of those benefits of the process which it was very difficult to assess exactly.

On the motion of the Chairman (Dr. J. J. Fox) thanks were accorded to the authors and also to the Gas Light and Coke Company for permitting the results of the work to be published.

National Gas Council

Meeting of Central Executive Board

A Meeting of the Central Executive Board of the National Gas Council was held at 28, Grosvenor Gardens, London, S.W. 1, on Tuesday, March 13—Sir DAVID MILNE-WATSON, LL.D., D.L., in the Chair.

Joint Co-Ordinating Committee of the National Associations.—A report was submitted of a meeting of this Committee which was held on March 6. Arrangements were made with regard to the provision of a staff for the Technical Committee, thus enabling the work of recording and the circulation of information to be put into operation without delay. Arrangements were decided upon for the supervision of the Domestic Bureau, and it was agreed that reports from this Bureau should be made to the Joint Co-Ordinating Committee of the work undertaken and the policy proposed. A recommendation was submitted and approved that particulars of all methods of charge, including block charges and multi-part tariffs now being operated by gas undertakings, should be obtained and circulated among members.

British Industries Fair and the S.B.G.I.—It was decided that a communication should be sent to the Society of British Gas Industries, expressing the thanks and appreciation of the National Bodies for the support received from the Society in connection with the exhibit at the Fair, which has been such a marked feature of the Exhibition for so many years.

Gas Undertakings Bill, 1934.—It was reported that this Bill, which had been introduced by the Government and read for the first time in the House of Lords on Feb. 22, had received a second reading on March 8. Copies of the Bill had been sent to all members of the Council. The Board received a report from the Gas Charges Committee together with one from the Officers of the Council, and a Committee was appointed to deal with questions arising out of the Bill.

Coal Mines Bill.—A meeting of the Coal Committee of the Conjoint Conference of Public Utility Associations held on March 8 was reported with regard to the effect of this Bill, which seeks to modify Part I. of the Coal Mines Act, 1930, under the following two main directions—viz.:

(1) By abolishing the quantitative restrictions on coal for export, while retaining the minimum prices in relation thereto; and
(2) by requiring the Central Council to inquire into any complaint made by a Coal Executive Board for a district as to the operation of the provisions of any scheme in any other district relating to the determination of the minimum price of coal.

Oil.—It was reported that a Deputation had waited on the Secretary of the Coal Mines Department, Mr. Ernest Brown, on March 8, consisting of representatives from—

The Coal Utilization Council,
The National Gas Council,
The British Electrical Development Association,
The Creosote Export Producers' Association,
Low-Temperature Interests,
The Coal Burner Appliances Association, and
Makers of Steam Road Vehicles and Compressed Gas Cylinders.

The National Gas Council had been represented by Mr. S. S. Ogilvie.

The deputation urged—

(1) the necessity for the continuation of the tax on heavy oils;

(2) the necessity for amending Licence Duties on compressed gas vehicles—

(*a*) by disregarding the weight of cylinders and the necessary fitments and connections in calculating the total unladen weight of passenger vehicles propelled by gas; and

(*b*) by assessing other gas-driven vehicles for taxation purposes on their unladen weight, *less the weight of the cylinders and all the essential fitments and connections;*

(3) the reduction of the rates of Licence Duties for steam-driven vehicles.

National Smoke Abatement Society.—The Board discussed the proposal of the National Smoke Abatement Society to organize a Conference on Smokeless Fuels, and the possibility of setting up a Sales Organization to cover smokeless fuels produced by gas-works, coke oven works, and low-temperature carbonization. Mr. H. C. Smith, Chief Engineer of the Tottenham and District Gas Company, was appointed by the Board to attend this conference, together with one of the Officers of the Council.

Rating.—It was reported that a meeting of the Rating and Valuation Committee of the Conjoint Conference of Public Utility Associations had been held on March 8, when a lengthy discussion had taken place with regard to the various methods of assessing Public Utility Undertakers. A full report of the recommendations of the Committee is to be made to the Council of the Conjoint Conference, when the matter will be referred back to the various Public Utility Associations concerned.

British Refractories Research Association.—A further appeal from this Association for funds to carry on their work, addressed to gas undertakings, was considered, and the Board decided to give their strong support to the appeal and to suggest that it should be given wider circulation than that proposed, having regard to the importance of the work carried out by this Association.

NOTES ON PLANT AND PROCESSES

Suspension Gear for Gas Lamps.

A leaflet published by Messrs. W. Slingsby & Co., Ltd., of Woodhouse Road, Keighley, describes and illustrates the firm's "Wask" up-and-down suspension gear for gas street lighting.

The purpose of the "Wask" up-and-down suspension gear will be clear when we say that in operation it is possible gradually to lower the lamp, without risk of slipping or jerking of any kind from the normal position to one close to the side of the post on the footpath. This is contrived by two movements; the winch on the post controls the lowering wire, and the tubular arm from which the lamp proper is hung conveys the gas. By the use of malleable iron and gunmetal swivel fittings it is possible to change from horizontal over the roadway to vertical position by the side of the post on the path.

It will be asked how the lamp is held at the extreme end of the extension carrying arm and released when necessary. Here the device embodies a patented feature consisting of a malleable iron bracket with a splayed mouthed slot bolted to the cross arm; upon this bracket is fixed a bronze bar upon which slides a strong malleable iron hook for carrying an extension finger which forms part of the swivel carrying the lamp.

When the lamp is lowered for attention it is first raised, this operation causing the extension finger to come in contact with a supplementary lever swinging on a pivot in the hook, and to lift the lever to form an inclined plane so that on further raising the lamp the hook is moved sideways. The lamp is then lowered, and the finger passes freely down the slot in the bracket allowing the lamp to swing to the side of the standard. When the lamp reaches the bottom position its weight is carried on the hinged supply pipe, so that by further unwinding of the hoisting rope a supplementary pulley with rope and counterweight lifts the hoisting rope clear of the roadway.

To raise the lamp, the winch is wound up, which causes the counterweight to resume its normal position; then the lamp itself is raised until the finger on the lamp swivel first enters the splayed mouthed slot of the suspension bracket and then comes in contact with an inclined face of the malleable iron hook, when further raising of the lamp causes the finger of the swivel to draw the hook along the bronze bar until the supporting end of the hook is across the slot in the bracket. When the winch is now unwound, the finger of the supporting swivel falls to rest in the hook and releases the tension on the hoisting rope.

Complicated though the above may read, the sequence of movements is actually quite positive and very smooth, and experience has shown that it proves reliable in practice. It will be obvious that, except for the short period when a lamp is ascending or descending, the weight is carried by the secondary casting and not by the winch wire.

Inspection of Metro-Coalite Plant

On Thursday, March 15, a party of members of the Midland Junior Gas Association visited the East Greenwich Works of the South Metropolitan Gas Company, where they inspected the Metro-Coalite low-temperature carbonization plant and subsequently viewed the whole gas-works.

On arrival the visitors were welcomed by Mr. A. B. Andrews, Works Engineer, who presided at luncheon, which was served in the Company's fine Co-Partnership Institute. Also present were Mr. H. C. Sims and Mr. J. M. Webber, respectively President and Junior Vice-President of the London and Southern District Junior Gas Association.

On behalf of the Midland Junior Association, Mr. S. K. Hawthorn, their President, expressed the grateful thanks of the visitors to Dr. Carpenter and the Board of Directors of the South Metopolitan Company for the invitation to visit their works and for their hospitality. Their thanks were also due to Mr. Andrews for organizing the visit and for his kind welcome. He further expressed appreciation at the presence of the two officials of the London and Southern District Junior Association.

Mr. J. H. Wainwright, in seconding the vote of thanks, also thanked the Company for their hospitality, and said how much they were looking forward to their inspection of the works. He associated with the vote the name of Mr. Andrews.

Mr. Andrews, in response, said that at the East Greenwich Works they would observe two distinct branches of the Company's operations. The Metro-Coalite plant had only been in operation during the past four years. The product was an excellent one, and the demand for it was growing each day; it was playing its part in helping to clear away the smoke of the Metropolis.

The Metro-Coalite Plant.

The coal is brought by sea to a neighbouring Thames-side wharf and taken by railway wagon to the Coalite works. Here it is discharged by a wagon tippler and elevated by a bucket conveyor to the top of a reinforced concrete bunker, which is divided into two compartments each capable of holding 200 tons, so that two types of coal may be stored and blended as required. Blending is effected by discharging the coals in the desired proportions on to a common belt which conveys the mixture to a crusher from which it falls into a Büttner dryer. When necessary a blend of three coals may be prepared by withdrawing simultaneously from the two bunkers and the wagon tippler pit. The coal is removed from the dryer by a screw conveyor and elevated to the five retort house hoppers each of which holds 65 tons of coal—that is, sufficient for 24 hours' working of each battery. These hoppers are fitted with two bottom discharge doors which feed the coal into 12-cwt. travelling skips from which the retorts are filled. Provision has been made for by-passing the dryer and also for blending the Metro-Coalite breeze with the coal to be carbonized. The whole coal-handling plant is designed to deal in 14 hours with 230 tons of coal—*i.e.*, the daily consumption of the plant.

The Retorts.

There are eighteen retorts on each side of the five batteries, and although the retorts are uniformly spaced they are operated in pairs. Each retort consists of a vertical iron casting 9 ft. long, containing eleven carbonizing tubes into which the coal is fed, and also a smaller "gas tube." Each carbonizing tube holds approximately ½ cwt. of coal, and tapers from a diameter of 5¾ in. at the bottom to 4½ in. at the top to facilitate discharging. Actually the retort casting is now made in two parts, the division occurring horizontally half-way down the retort; this development cheapens the cost of the plant.

Each retort is closed at the bottom by a hinged door operated by a chain wheel outside the battery and provided with a hole coincident with the "gas tube." Below each pair of retorts is a common cooling chamber fitted with a water-sealed discharge door and lagged to prevent the temperature falling below that of the condensation of tar vapours. The function of the "gas tube" is to provide an outlet for the gases displaced from the cooling chamber when a new charge of hot Metro-Coalite is admitted thereto, and for any gas evolved from the hot charge while in the cooling chamber.

Gas is withdrawn through 6-in. cast-iron pipes with a movable disc inside each to counter the pitching up of the pipes. The connection between the retort and the hydraulic main is made by means of a water seal, which is kept full by condensate from the gas. The same pipe which terminates in the water seal at its upper end carries a Cort's anti-dip pipe at its lower end for sealing off the retort during charging and discharging. The hydraulic mains are flushed periodically with water to remove any deposit. The gas is withdrawn from the hydraulic mains and passes through governors to the exhausters in the normal manner.

Method of Heating.

The gas for heating the retorts is supplied under constant pressure through a ring main encircling the battery, the quantity admitted to each burner chamber being regulated by valves. Air for combustion is supplied under pressure through a rectangular main and, before being admitted to the burner chambers, passes through a series of 4-in. cast-iron recuperator tubes heated by the waste gas.

The retorts and combustion chambers are arranged alternately, making 19 combustion chambers and 18 retorts on each side of the battery. In order to facilitate the careful control of temperature necessary for the correct working of the plant, twelve portable pyrometers are fitted to each battery, all the leads being brought to a pyrometer house.

Owing to the fact that the temperature inside the retorts never exceeds 600° C. the shrinkage of the charge during carbonization is small, which limits the choice of coals to medium-swelling varieties or to suitable blends.

The operation of charging and discharging the retorts takes place every four hours, the procedure being as follows. The pair of retorts to be charged is isolated from the hydraulic main by lowering the anti-dip seal. The door of the cooling chamber is then opened, and the cooled charge of Metro-Coalite is dropped on to a tip tray conveyor which transports it to the primary screens. After closing the chamber door, the bottom doors of the retort are opened and the carbonized charges are allowed to fall into the empty chamber. The bottom doors are then closed, and, after plugging the two "gas tubes" to prevent entry of coal, the other tubes are filled by the travelling coal skips.

Metro-Coalite Handling.

The Metro-Coalite discharged from the two rows of cooling chambers, one on each side of the battery, falls on to a central tip tray conveyor and passes over vibrating screens into a continuous bucket elevator which encircles the Coalite storage hoppers. On its way the product is sprayed with water to complete the cooling and reduce dust trouble. The storage hoppers are four in number and have a total capacity of 600 tons—or the output from three days' working. Each hopper is provided with four bottom discharges equipped with automatic weighing devices for filling 1-cwt. sacks or 28-lb. bags.

The whole low-temperature plant is capable of handling twice the volume of gas that would be produced by the five batteries, and ample space is available for the installation of additional batteries and bye-product plant if the need arises.

Having completed their inspection of the Metro-Coalite plant, the visitors were taken over the remainder of the East Greenwich Works, including the coal jetty, horizontal retort houses, benzole washing plant, governor and booster houses, machine tool, boiler, riveting, blacksmiths' shops, &c. Before leaving, they were entertained at tea, when Mr. Hawthorn took the opportunity of expressing the Association's indebtedness to the guides, on whose behalf Mr. Andrews briefly returned thanks, remarking that he hoped it would not be the last occasion on which they would have the pleasure of entertaining the Midland Juniors.

Radiation Limited

ORDINARY GENERAL MEETING

At the Annual Meeting of the Company held at The Incorporated Accountants' Hall, Victoria Embankment, London, W.C. 2, on the 21st March, 1934, the Chairman, Mr. H. James Yates, in moving the adoption of the Report and Accounts, said:—

It is with pleasure that I am able to propose to you the adoption of a satisfactory Report of our trading for the past year. At the beginning of the year, trade was none too good, and the horizon was far from clear, but things gradually began to assume a healthier aspect. This improvement arose from a number of causes. Undoubtedly confidence has been returning to this Country; we appear to be bearing the strain of the depression more successfully than other nations. Although the return of confidence has been of considerable assistance to our Company, as it must have been to many other manufacturing concerns, there are other important factors which have materially assisted our trading during the past year and to these I propose to refer after dealing with the Accounts.

Copies of the Report and Accounts have been sent to all Shareholders and you will have observed that in addition to the Balance Sheet of Radiation Limited there is the usual statement showing the combined assets and liabilities of all the Subsidiary Companies.

From the Profit and Loss Account it will be seen that the net income from the Subsidiary Companies, including Transfer Fees and Bank Interest, amounts to £299,965, which compares with the sum of £288,785 for the previous year; there is thus an increase of £11,180 for the year 1933.

On the opposite side of the Profit and Loss Account you will notice that a transfer of a further £50,000 has been made to General Reserve, increasing the amount of that Reserve to £165,142, as shown on the Balance Sheet above.

The balance of the Profit and Loss Account for the year, amounting to £299,909, is carried to the Balance Sheet and after deducting the amount of the proposed Final Dividends there is a balance of £116,354 which it is proposed to carry forward to next year.

On the Assets side of the Radiation Balance Sheet the principal item is the amount £3,732,583, consisting of the cost to Radiation of Investments in Subsidiary Companies and amounts owing by those Subsidiary Companies, including Dividends declared for the year 1933.

I now turn to the statement showing the combined Assets and Liabilities of the Subsidiary Companies, and, on the Assets side, it will be seen that the figures for Land and Buildings have increased from £821,962 to £823,364 and the Plant and Machinery from £310,668 to £313,322. The increases are not large, but it must be remembered they are net after deducting depreciation and obsolescence.

Stocks, Sundry Debtors and Cash Balances have increased by amounts totalling £244,836, but on the other hand you will see that Sundry Creditors have increased by £136,039.

There is a small increase in the item of Investments, which now stands at £1,875,472.

On the Liabilities side of the statement there is the item £3,732,583, which appears also in the Radiation Balance Sheet, and I have already referred to this amount.

The next item on the Liabilities side is the balance of £138,923, remaining to the credit of Profit and Loss Accounts; the comparative figure a year ago was £60,006. In the previous year's statement this figure of £60,006 was arrived at by deducting from the balance of undistributed profits of Subsidiary Companies the item of Goodwill, which you will remember represents the excess of the cost to Radiation Limited, of the investments in Subsidiary Companies over the net assets of those Companies at the date of merger. The Subsidiary Companies have, however, this year specifically set aside out of undistributed profits, sums sufficient to eliminate the amount of Goodwill as shown in former years' statements.

As regards this item of Goodwill: from the formation of Radiation in 1919—15 years ago—when this intangible asset came into existence by the terms of the merger, I have been looking forward to the day when this so-called asset would disappear from our figures. I am glad, therefore, that this has now been accomplished and I know that such a course of strengthening the position of a business is one welcomed by every shareholder.

You are aware that we spend a large sum of money in advertising in the daily press and in many other directions. Indeed, as gas apparatus makers, we led the way by launching a big advertising propaganda in the press. As a result of our extensive advertising we have been able to bring before the householder the numerous advantages of using the "New World" Gas Cookers, and the Gas Fires, Water Heaters, etc., made by Radiation, and I have no hesitation in saying that if householders will always insist upon having Radiation goods, they will obtain apparatus so constructed as to ensure better results and more economical use than can be attained with any other similar apparatus. This is due to our continued Research work, which has extended over many years, involving very heavy annual expenditure, and further, to the fact that we possess the largest and best-equipped Gas Stove factories in this Country, covering some 200 acres. Radiation goods are the best: they may not always appear to be the cheapest to buy but they are the cheapest to use, and therefore the cheapest in the long run.

As a result of our Research work, we continue to develop and increase the efficiency of our existing apparatus as well as to introduce new apparatus from time to time. Where we find that a better type of material, or new method of manufacture, can be used in our appliances to enhance their wearing properties and so prolong their life, and to add to their general utility, we never hesitate to adopt such materials and improvements, notwithstanding the regrettable fact that in most cases the cost of production is increased and very often there is only a small margin left between the cost of the article and the selling price. It has been necessary to meet this encroachment on our profits by greatly increasing our output, and owing to this larger volume of trade, we have been able to increase our aggregate amount of profit although the profit on the individual article has been less. To enable us to deal with this continually increasing turnover, we have for some time past been making additions to our buildings and plant, and at the present time we have large extensions in progress in a number of our Works. As we have created such a demand for our goods, we must be in a position not only to meet that demand but also to ensure its continuance; otherwise, if extensive Works are not fully occupied, profits will diminish at an alarming rate and often disappear altogether. Fortunately we are not confined to one particular trade; our ramifications are great and widespread, but they all link up one with another. Our trade necessitates the use of many processes and materials. This has led us to establish other businesses which, while distinct, are really ancillary to the general business, and make a substantial contribution to our total profits.

It will interest you to know that, apart from our increased sales in this Country, our Export trade also has improved in spite of the fact that we have to combat very high tariffs. We continue to hold demonstrations of our "New World" Cooker in various parts of the world, and the popularity of these demonstrations is increasing. In a town with a population of 1,100,000 we gave demonstrations of our "New World" Gas Cookers, extending over a period of 7 days, and they were attended by over 24,000 people. In another country abroad, in a town with a population of 135,000, two demonstrations were given and nearly 3,000 people attended. In yet another town, where one demonstration was advertised, 1,600 people attended and overflow demonstrations had to be given in other halls.

During the past year, Sir David Milne-Watson, the Governor of the Gas Light & Coke Company, did us the honour of formally opening our new Central Research and Demonstration Kitchen at Radiation House. Our own staff of expert cooks is continually experimenting with new recipes and the results are embodied in the Radiation Cookery Book, which is now in its 17th Edition. So great has been the demand for this authentic and reliable book that if the paper used were stacked in reams, it would form a column nearly three times the height of St. Paul's Cathedral. Not only does our Cookery Book include recipes for practically everything required in most households but it gives the tested "Regulo" setting, and the correct cooking time, for every operation in the "New World" oven.

Competition between Gas and Electricity continues to grow. Healthy competition is good for all trades, and the competition of electricity can be made the means of bringing before householders the great advantage of using gas for cooking and heating, in a way they have never realised before. Gas Undertakings, however, are at present hampered by antiquated legislation: existing restrictions should be removed and, in particular, Gas Undertakings should have more freedom of action in fixing the charges to be made for gas. There is a further matter in connection with the selling of gas apparatus regarding which we in Radiation have a proposal to make. At present it is not easy to make clear to the public the comparative charges for gas and electricity. Electricity is sold by the unit, with various methods of charging; sometimes the consumer pays so much per unit for lighting and a lower price per unit for heating and cooking, or frequently another method of charging known as the two-part tariff is used. By this method, in addition to the charge per unit, a fixed quarterly charge is made, generally based on the rateable value of the house or on the area of the living-rooms. The only way, however, of determining the real charge for each unit of electricity supplied, is to ascertain the total charges made and divide by the number of units used.

A further difficulty in comparing the prices of Gas and Electricity lies in the present disparity between the heat-value of the gas "Therm" and that of the electric unit. It is generally overlooked that the "Therm" is equivalent to 100,000 British Thermal Units of heat whereas the electric unit is equivalent to only 3,412 of the same heat units. We strongly advocate the use of a smaller measure by gas salesmen and recommend a "gas unit" of 4,000 British Thermal Units, which is one twenty-fifth of a Therm, the price of the "gas unit" being found by multiplying the price of the Therm by 4 and dividing by 100. For example, with gas at 9d. per Therm, the price of the "gas unit" of 4,000 B.Th.U. is 0·36d., i.e., less than ½d.

In this way the price of the " gas unit " can readily be calculated from that of the Therm in any district and can then be compared with the price of the electric unit (kilowatt-hour) ascertained, as I have said, by dividing the total charges made by the number of these units used.

I am confident that if the " gas unit " were adopted, salesmen would be able to state to their customers in a simple manner, the cost of using gas appliances, and householders would realise how much cheaper, for many purposes, it is to use gas rather than electricity.

I would like to remind you again that, as a result of our study of some of the reactions of the human body to the influence of radiant heat, we have long realised the value, as a therapeutic adjunct, of short infra-red energy. Short infra-red energy has the property of penetrating the epidermis (cuticle), reaching the derma, or true skin, and of stimulating the blood-flow in the capillaries. This stimulation of the blood-flow is beneficial and results in a sense of greater comfort than is the case with energy of the longer infra-red type.

Our " Beam " Gas Fires and the Radiation Clinical Gas Lamps embody the results of our Research work in this direction, by which heating by gas has been placed on a plane never before reached. The warmth from our " Beam " fires, apart from its comfort, is of definite stimulative value to health, and our Clinical Gas Lamps are finding an increased application in Hospitals and Clinics for the alleviation of the pain and discomfort caused by rheumatism, neuritis, lumbago, and kindred ailments. These appliances have still further assisted in associating Gas with Health.

Recently we introduced another type of gas fire called the High " Beam." There are new and important features in its construction. Its radiant efficiency is greater than that of any gas fire yet marketed. Further, we have incorporated in the High " Beam " fire a valuable feature, viz.—the Self-lighting Gas Tap. It is only necessary to turn on the gas by means of this tap and the fire lights up automatically. We confidently anticipate that this new fire will become increasingly popular.

I have reminded you on a number of occasions that we were the first to apply to a gas cooker an absolute reliable thermostat. For this we have our Registered Trade Mark, descriptive of the thermostat itself, viz., " Regulo." The " Regulo " not only takes absolute control of the oven temperature and ensures perfect cooking, it also ensures economy in the consumption of gas. It has been proved by millions of users all over the world, that it is only necessary to place the food in the " New World " oven, set the " Regulo " to the proper figure, note the time, and remember to open the oven door once the proper time has elapsed, when it will be found that the food is perfectly cooked. This is all summed up in our slogan:—

" TRUST THE 'REGULO' FOR PERFECT COOKING."

The word " Regulo " for a gas oven thermostat is known all over the world. The " Regulo " can only be obtained in apparatus manufactured and sold by the Radiation Companies, and I want to lay emphasis upon this because, now that many gas ovens are being fitted with a thermostat, it is necessary that people who are anxious to obtain a " New World " Cooker with the " Regulo " should insist on seeing these names on the appliance. There is only one " Regulo "—the thermostat supplied by Radiation.

" Radiation " has come to be regarded as the Hall Mark of all that is best in gas apparatus. " New World " is the Hall Mark of the most efficient gas cooker made. " Regulo " is the Hall Mark of the most reliable thermostat made. " Beam " is the Hall Mark of the most serviceable gas fires made—and all these valuable Trade Marks are the creation and the property of your Company.

Before concluding my remarks, a most pleasant part of my duty to-day is to remind all our shareholders how greatly the long-continued success of this business is due to the good fellowship and co-operation which exist among all those in the service of the Company. We have employees who have been with us for over fifty years. From time to time as I go round the Works with which I have been particularly associated, I receive a smile of greeting from some of my old friends who were with me forty years ago and who are still happy in their occupation. In many instances their children are with us and, in some, even their grandchildren.

I have pleasure in moving:—

" That the Directors' Report and Accounts for the year
" ended 31st December, 1933, as presented by the Directors,
" be received and adopted, and that Final Dividends be
" declared as follows:—3 per cent., less Income Tax, for
" the half-year to 31st December, 1933, on the 6 per cent.
" Cumulative Preference Shares; and 9⅜ per cent., less In-
" come Tax, on the Ordinary Shares, making, with the
" Interim Dividend paid in October, 1933, a total Dividend
" of 12½ per cent. on the Ordinary Shares for the year."

Plane Surveying and Its Application to Gas Engineering*

By HAROLD S. MILNE, B.Sc. (Eng.), Greenock.

In view of the sensitiveness of the theodolite and level it is highly important that the instruments should be handled with the utmost care. Force should never be used in making adjustments, or in replacing the instruments in their cases.

An instrument should only be set up on firm ground and should be left in position only so long as is absolutely necessary. The feet of the tripod should always be securely placed, and when widely spread, as, for example, in windy weather, they should be prevented from slipping outwards by placing them against a suitable stop.

Accurate results can seldom be obtained in windy weather unless the instrument is sheltered, while difficulty will be experienced in holding a levelling staff steady and plumb when fully extended.

When making a survey, it is usual to fix its position by referring it to a base line, the position and direction of which is known. The frontage of a building or a line parallel to it may be usefully employed as a base line, it being a further advantage, when possible, to adopt this line as one of the main lines of the survey. In setting out works it is usual to refer all measurements to the centre line or to a line parallel or perpendicular to it; the important point being to select a line which is conveniently placed with regard to the work in hand, and yet which is not likely to be interfered with as the work proceeds. When this line is once established its position should be clearly indicated by marking the ends and intermediate points by chisel marks, if on stone or metal, or by means of nails in pegs driven into the ground. In the same way reference levels should be established at convenient points about the site of works.

When running the main lines of a survey, care should be taken that the triangles formed are well conditioned—that is, that they approach the equilateral condition, in order that distortion produced by errors of measurement and plotting may be a minimum. As few lines as practicable should be used for the framework, while, whenever possible, lines not necessary for obtaining details should be avoided.

In order to eliminate the possibility of errors in measurements or in plotting passing unnoticed, it is usual to include check lines between various points in the frame work. Local circumstances will dictate how these lines should be run, the commonest case being perhaps the inclusion of a second diagonal in a four sided figure. When measuring the angles of a closed figure by means of a theodolite, it is usual to end by sighting back on the starting point in order that any inaccuracy in the work may be located. If a small closing error is obtained it is usual to distribute it equally among the readings, unless, by reason of difficulties encountered, the probability of error is greater in the case of one particular measurement. In the same way, when levelling it is usual to level back to the starting point (not necessarily by the same route) in order that the work may be checked.

WORKING ROUND OBSTRUCTIONS.

It may happen that an important line is obstructed in such a manner that it is impossible to range it either from end to end or to measure its length continuously. Such a difficulty can usually be surmounted by working round one side of the obstacle either by means of a line parallel to the original line, by applying the properties of similar triangles, or by setting up the theodolite at a point outside the line in such a position that the end stations can be sighted, and their distance from the theodolite measured. Thus, two sides and the included angle of a triangle are obtained, and the length and direction of the remaining side can be obtained by solving the triangle.

One useful case occurs when two stations are not intervisible on account of intervening high ground, but are both visible from the intermediate points. Ranging poles should be set up at the station points A and B and carefully plumbed (fig. 1). The Surveyor C and his assistant D

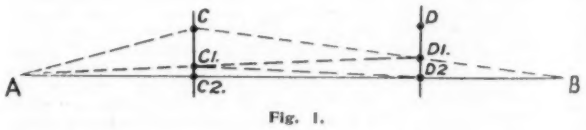


Fig. 1.

should take up positions between the stations and roughly in the line so that C can direct D into line with B, and D in turn can direct C in line with A. C and D should direct

* From a paper before the Scottish Junior Gas Association (Western District), Glasgow, March 10, 1934.

each other alternately in this manner until they are both placed exactly on the line A, B. This method will also be found useful when ranging a long line on level ground, particularly if the light is bad and the distant station cannot be distinguished clearly with the naked eye.

When a theodolite has to be used in an exposed position or where there is traffic, it is occasionally useful to range lines first by eye, particularly if intermediate points must be established at definite distances along the line. These points can be marked approximately along the line and at the correct distance along it and finally fixed by sighting from end to end with the theodolite. It is always best when sighting a ranging pole, to view it as near the ground as possible, yet there are occasions, as for example, in a busy street, when it is advantageous to sight the top of the pole, provided it is straight and has been carefully plumbed. If the sight is long, a flag may be tied to the pole to render it more conspicuous.

When setting out, provided the sight is short, a point can be fixed with great accuracy by sighting on a pencil held on the point, or, if the point is below ground, by sighting on the string of a plumb line.

"Offsets."

The detail of a survey is generally filled in from the main lines, usually by means of offsets. Distances are measured along the line and the perpendicular distance to objects on each side is measured from the line. If the distance from the line is great, or if the exact position of the object is important, the perpendicular may be set out accurately by means of instruments. It is more usual, however, to locate such objects by tying them by two or more measurements—that is, by measuring their distance from separate points on the main line.

To save time, when there is much detail, it is helpful to locate only the frontages of buildings and the like, from the main line, and to fill in the details later by referring to the building line or to a subsidiary traverse.

Fixing of Levels.

The fixing of levels forms a very important part in the setting-out of new works, and this work should be fully understood and very carefully performed, as a small mistake in a level may occasion much loss of time and money. For example, concrete bases for stanchions are usually cast to about 1 in. below finished level, the foundation bolts being cast in with the concrete. The stanchion base is supported above the concrete by means of steel wedges so that the height of the stanchion may be adjusted slightly to suit the remainder of the steelwork. An error of 1 in. in the height of the foundation might possibly pass unnoticed until much of the steelwork is up, and would only become apparent when the erector foreman is lining in the work preparatory to grouting in the holding down bolts. With the foundation high it would be necessary to chip the concrete down to the correct level, unless it were possible to adjust the steelwork by means, for instance, of slotted holes. While if the concrete were too low, the foundation bolts would probably be found to be of insufficient length. In either case, it would be necessary to support the stanchion clear of the foundation while making adjustments, a procedure bound to cause unnecessary delay and expense.

The most satisfactory method of setting out for buildings and plant is by means of profile boards. If, for example, in a steel frame structure, the foundation plan shows the columns set in regular rows, pegs, positioned by means of the theodolite, should be driven into the ground a few feet outside the building line so as to define lines parallel to the rows of columns and at a definite distance from the face of the steelwork. To the sides of these pegs are nailed wooden boards about 6 in. wide so as to fix a datum vertical plane to which the position of the foundations, steelwork, and walls can be referred. The top edges of the boards are set by means of the "dumpy" to a definite level, usually a whole number of feet above or below datum. The centre lines of the rows of columns are marked on the boards and the position of each column is located by the intersection of lines strained between the marks. Levels are determined by sighting across the boards, by measuring down from a tightly stretched line, by means of a builder's level and straight edge, or, most accurately, by means of the "dumpy."

When trenches have to be excavated to a stated depth, as for instance, for the foundations of walls or for drains, it is most convenient to make use of sight rails. These consist of a board fixed between posts driven on opposite sides of the trench in such a position that they shall not be disturbed by any of the subsequent operations. Levels obtained by means of the "dumpy" are marked on the posts, and the board is nailed so that its top edge corresponds with the marks. For convenience the centre line of the trench is generally marked on the board. A similar sight rail is fixed further along the trench, with the rail at the same level as the first in the case of a level bottomed trench—or at a previously determined height above or below it when a gradient is required. By sighting across the rails, a line of sight is obtained which corresponds with the finished bottom of the trench, and from which intermediate points can be fixed by means of boning rods.

Transferring Levels.

Some difficulty may sometimes be experienced in transferring levels, particularly when erecting plant, on account of obstructions interfering with sighting, or with the use of a straight edge and builder's level. On such an occasion an improvised "U" tube may frequently prove serviceable. Two glass tubes are connected by a sufficient length of rubber tubing, and the whole filled with water. One tube is held so that the surface of the water is at the level to be transferred, while the other tube is held at the point where the level is required, or at a point conveniently situated with respect to it, and the level of the water marked.

An important application of levelling is in the preparation of sections. These may be either longitudinal sections taken along the line of proposed new works, or cross-sections taken at various intervals along the line and perpendicular to it. Levels are taken by means of the "dumpy" by sighting along a line at all points at which the inclination of the ground sensibly changes, a note being kept of the distance of each point from the starting position. The levels obtained are plotted vertically on a base of distance, the vertical height scale being exaggerated compared with the horizontal distance scale by an amount depending on the variation in the levels, in order that the nature of such variations may be more clearly shown.

From such sections, much useful information may be obtained regarding a proposed site, particularly with reference to the taking out of quantities for estimating the amount of excavating and making up required, factors which may influence the cost of a scheme to a considerable extent.

When an existing structure has to be reconstructed, data regarding the deformation of certain of its members, together with particulars of modifications not shown on the original drawings, are of the utmost service to the draughtsman preparing the drawings for the reconstruction.

Interesting examples of the necessity of this may be found in the case of a reconstruction of a vertical retort bench. The main stanchions supporting the bench may be found on plumbing to have developed a "lean," or to be buckled and incapable of sustaining an increased load without being strengthened. The floor joists supporting the setting may be found, on taking spot levels, to have deflected to a greater extent than is considered satisfactory, and may have to be straightened, or, in a bad case, replaced by a heavier section. Existing buckstays require to be plumbed carefully in order to ascertain if they shall be sufficiently stiff for their new duty, and to ensure that none of the new work will be fouled by a badly bowed buckstay. End walls also should be plumbed, so that the material for any work necessary there can be put in hand to go forward with that required for the setting.

It is practically valueless to plumb individual buckstays without referring them to the structure as a whole. The centre line of the main storage hopper supporting joists should be established and the distance of all plumb lines measured from this. A plumb line consisting of a thin steel piano wire with a weight of several pounds on the end should be hung clear of the face of the buckstay, the weight being immersed in a bucket of water in order to damp the swing. The distance from the wire to the face of the buckstay should be measured at definite points, particularly at the levels of platforms and horizontal bracings, the final measurement being taken to the centre line of the floor joists or of the main supporting stanchions.

There are cases when it is difficult, or indeed impossible, to plumb a structure in the usual way, as, for example, in the case of a high chimney. For work of this kind the theodolite can very well be employed. The instrument should be carefully levelled by means of the telescope level, on account of its greater sensitivity, and the telescope elevated to sight on the extreme edge of the coping. All horizontal movement must be clamped, and the telescope lowered so as to sight on the ground at the chimney base. This point should be carefully marked. The operation should now be repeated for the opposite edge of the coping, and the mean of the two marks compared with the centre line of the base. As a check on the instrument adjustment the first operation should be repeated with the telescope transited in order to verify that the line of sight does actually trace out a vertical plane.

The magnetic compass is frequently used as a surveying instrument and is capable of producing some very accurate and rapid work. It has, however, the disadvantage that it is easily influenced by local conditions, as, for instance, the presence of steelwork or magnetic fields produced by elec-

trical plant, and on that account is of little use on a gas-works.

Sounding Shipping Berths.

Some gas-works are in the happy position of having their coal brought into their works by water, and it may therefore not be out of place to conclude with a few remarks regarding the methods employed in sounding shipping berths. The purpose of sounding is similar to that of levelling in land work, and is the determination of the levels of the under water surface.

The simplest and most satisfactory manner of obtaining soundings about wharfs and waterways is by means of the cross rope method. A rope marked clearly at intervals of 10 to 25 ft.—according to the amount of detail required—is played out from a boat rowed along a line at right angles to the shore. The ends of the rope are made fast, and the rope pulled taut. A second boat, carrying the surveyor, is now pulled along the rope, and the depth of the water is obtained at each mark by means of a sounding line, consisting of a weight attached to a rope marked at one foot intervals by means of cloth or leather tabs, every 5 ft. being distinctively marked, while the tabs at every tenth foot should have the reading figured on them. The surveyor notes the depth of water to the nearest quarter of a foot, corresponding to the distance along the cross line, and, if in tidal water, notes the times at which the section is commenced and completed.

On the completion of one section, the cross rope must be wound in and played out again in a similar manner for the next section, which should be parallel to the first, and at a distance of 25 to 200 ft. from it, depending on the purpose of the work.

In tidal waters the level of the surface of the water is constantly changing, and it is therefore necessary to adjust the booked depths to allow for this, by noting the rise or fall of the water against a fixed board, at five-minute intervals, the time of each reading being observed on a watch synchronized with that of the surveyor.

Soundings for special work may be plotted on a distance base in a similar way to a cross-section in levelling, but so far as access for shipping is concerned, it is better to plot the corrected value of each sounding on a plan of the area surveyed and, by interpolation, to mark in lines to represent definite depths such as 10, 15, and 20 ft. Ease of reading will be increased if each area of depth is indicated by a wash of prussian blue, the intensity of the colour increasing with the depth.

Discussion.

Mr. John Greig (Glasgow) said that he was glad that Mr. Milne had pointed out the necessity for accurate surveying carried out by reliable instruments. This was particularly desirable when extensions were in view, and when no data were available concerning the previous work. In the Gas Industry extensions were always being made, and he thought that the practical details given in the paper would be useful. One point he would like to mention was the erection of works on inclined sites. In all cases use should be made of the incline, particularly where heavy materials such as coal and oxide were being handled.

Mr. Webster (Port Glasgow) said that the necessity for using surveying instruments in works occurred fairly seldom, but when the necessity did arise it was usually found that knowledge of these instruments was lacking. He had some experience of the use of the theodolite, and had also used the "dumpy" level to gauge the settling of a new holder when filled with water. The "dumpy" was set up, marked to datum, and the levels read off. It was found that the holder was settling more on one side than on the other. The "dumpy" level was also very useful for planning the lay-out of drains, particularly surface drains. Drains laid down haphazardly often caused trouble through flooding.

Mr. R. D. Keillor (Greenock) said that he had no doubt that this branch, though specialized, entered directly into gas engineering and distribution. Pretty drawings, he said, were useless unless they were obtained on scientific principles, and there was too great a tendency to take plans for granted without probing into them carefully. Plans must always be accompanied by a section. He then asked Mr. Milne to show how parallax was eliminated. He also thought that it would be of interest if Mr. Milne would explain what the figures on an Ordnance Survey map meant, and how such a map could be read.

Mr. McGown (Glasgow) asked how it was possible to determine the height of one position relative to a second when the second was not visible from the first.

Mr. Bujnowski (Glasgow) asked if, in levelling a large area, it was usual to take the levels of a large number of points.

Mr. Kirk (Falkirk) asked if the miner's level would not be a more convenient instrument than the "dumpy" level for measuring levels of two places which were not visible from one another.

Author's Reply.

Before replying to the questions, Mr. Milne set up the "dumpy" level and demonstrated how levels were determined. He pointed out that the method of obtaining levels of points not inter-visible was to do so by reference to a third point which was visible from both. He did not see that the miner's level, which was a glorified magnetic compass, had any advantage over the "dumpy" level. Mr. Greig's point of making use of inclines was one which should always be considered. Mr. Webster, in mentioning the use of surveying instruments in observing the settling of a holder, had brought forward one of the many applications of surveying in gas-works. In reply to Mr. Keillor, Mr. Milne explained the contour lines on an Ordnance Survey map. On these maps heights were given by contour lines which were based on the Ordnance Datum (the level of high water at Liverpool). On town survey maps contour lines were not given, but by drawing lines between the bench marks it was possible to make a contour line and get the level of any particular point.

Newcastle-London-Normanton on Gas Fuel

A Record Run

A series of exhaustive tests has been carried out by the Whitwood Chemical Company, Ltd., of Normanton, on a lorry running on coal gas. Through the courtesy of Mr. G. Gerard Wilson, General Manager of the Company, a representative of *O'Connell's Coal and Iron News, Wagon Owner, and Transport Gazette* had the opportunity of being an independent observer, and the following is taken from his account in *O'Connell's* for Feb. 22:

The lorry was originally a "Bristol" 'bus, and has been converted to working on a system using enriched coal gas. The conversion of the vehicle and the adaptation for using compressed gas in this form was carried out by the Whitwood Chemical Company themselves.

The trial runs extended in all to approximately 670 miles over a period from Sunday midnight to the following Saturday night.

Coals to Newcastle.

The first part of the run, starting at 12 midnight Sunday, consisted of taking four tons of coal from Normanton to Newcastle-on-Tyne. The journey was accomplished in five hours without a mechanical hitch of any description. After re-fuelling at the Newcastle Gas-Works, the coal was delivered to the offices of the South Metropolitan Gas Company, 34, Clayton Street West, and the lorry then proceeded to Great Hartlepool, where a load of pit props was taken on board and at 4 p.m. a commencement was made for the journey to Normanton.

The Fog.

After about an hour and a half, thick fog was encountered, which necessitated travelling 40 miles in low gear. Although the journey to Normanton was impeded, it was not held up, and there was still gas fuel left when the lorry reached Normanton, despite the additional fuel consumption necessitated by the adverse weather conditions.

During Tuesday, the pit props were unloaded, the lorry re-fuelled at the Whitwood Chemical Company's Filling Station, and then loaded with coal.

The next part of the trip, which started at 2 a.m. on the Wednesday, was to London *via* Birmingham, with 4½ tons of coal. Birmingham was reached at 9.30 a.m., and after re-fuelling at the Windsor Street Works of the Birmingham Corporation Gas Department, which took five minutes, a start was made at 11.30 a.m. (after an interval for meals) for London, which destination was reached at 6.45 p.m.

On Thursday morning the gas cylinders were re-charged

at the Fulham Works of the Gas Light and Coke Company, before proceeding to the Metro-Coalite Works of the South Metropolitan Gas Company, to unload. While at the works, the lorry was inspected by many of the Gas Company's officials, and in the afternoon a demonstration was given outside Thames House, to representatives from the Coal Utilisation Council, Imperial Chemical Industries, Associated Portland Cement Manufacturers, and other important organizations.

On Friday morning, a further demonstration was given at Westminster, when the vehicle was examined by important officials interested in transport problems.

Return to Normanton.

The return trip to Normanton was started early Saturday morning, but after travelling a few miles fog was encountered, thus impeding the homeward journey. Upon arrival at Birmingham, the lorry re-fuelled at the Windsor Street Gas-Works and then proceeded to Normanton.

It must be recorded that during the whole trip of approximately 670 miles, no mechanical trouble whatsoever was experienced.

It was in 1933 that experimental passenger carrying 'buses running on compressed coal gas were introduced in Chesterfield, Birmingham, and Newcastle, while at Normanton, the Whitwood Chemical Company had their first experimental lorry. The lorry had six gas cylinders (made by the Chesterfield Tube Company, Ltd.), interconnected to a two-stage governor made by the Bryan Donkin Company, Ltd. Throughout the trip there was no difficulty in starting. This is because the fuel is already in gaseous form and good carburation is, therefore, assured.

Cruising Range.

Objections were at one time raised on the question of the limitation of cruising range, but this difficulty has been overcome by a patented process whereby low-grade fuels are utilized in conjunction with the gas supply, thus resulting in a considerably increased mileage from one charge of gas, but without increasing the over-all fuel costs. It was this device which made possible the trip in which *O'Connell's* had an opportunity of taking part.

Hitherto, the range of operation of a gas-driven lorry, with similar equipment, has only been about 60 miles, and by many authorities this was considered a detriment to this form of propulsion. However, with the patent augmented fuel supply, runs up to 150 miles have been obtained.

The consumption of fuel on the 670 miles journey was 9,400 c.ft. of gas and 27 gallons of low-grade oil.

Basing on the actual prices paid for gas and oil, the all-in costs of this journey work out at a figure below any other form of road transport. However, owing to the variation in prices of gas in different parts of the country, these costs would vary in different districts, but it is hoped that before long the Gas Industry will realize the possibilities of a new and valuable consumer, and will endeavour to meet this position by some standardization of charges, with a view to developing this new phase of traction by the installation at appropriate points of suitable standardized compressing plants, and thus using our national resources to their own and the coal industry's best advantage.

IN CONTINENTAL COUNTRIES - - -

Abstract Translations from the Technical Press of France and Germany.

TAR EMULSIONS IN SMALL GAS-WORKS.

F. Sonnabend, in *Das Gas- und Wasserfach*, 1934, 77, 104-105 (Feb. 17), describes a cheap device which was installed at Pommerensdorf to deal with emulsified tar obtained from horizontal retorts steamed by the Goffin process. A vertical cylindrical tank 5 ft. 6 in. in diameter by 8 ft. high and some gilled heating tubes 34 in. long were obtained from a scrap metal merchant. The tubes were fitted together into four horizontal sets of three by means of headers, and the sets, arranged one above the other, were connected together by means of pipes alternately at one end and the other. Tar was admitted to the top of the tank and hot water was passed from top to bottom in a zig-zag course through the heating coil system which had been fixed into the tank. Due to the fact that the hottest portion of the heating system was at the top, convection in the tar was hindered, and re-mixing of the separated tar and water was prevented. Since ample tar storage was available, the emulsion was treated only during the warmer months; hence there was no need to provide special insulation for the tank, which was erected outside a south wall of the instrument house, and was painted black so as to be able to absorb solar radiation well. The tank was fitted with a wooden roof. With the arrangement it was possible to heat the contents of the tank to 80° C. in 48 hours. The settled tar withdrawn from the bottom of a tank had a liquor content of 5%.

A NEW CORROSION-RESISTING ALLOY.

H. Kalpers, in *Brennstoff-Chemie*, 1934, 15, 98 (March 1), refers to a new alloy Corrix-Metal of composition Cu 88·1%, Al 8·7%, Fe 3·05%, made by Corrix-Gesellschaft, m.b.H., Essen. The above analysis shows that the constituents employed have a high degree of purity. The alloy, which is made by a special melting process, is a eutectic; hence no local elements due to potential differences can arise in it. Corrix-Metal can be cast as well as drawn. It shows good resistance to sulphuric and several other acids, as well as to alkalis, sea-water, and steam. In the case of hydrochloric acid and ammonium chloride, the alloy is at first attacked rather severely, but the rate of corrosion falls off and finally a state of equilibrium is reached. In most cases, the alloy has the chemical resistivity of the austenitic chrome-nickel steels, and is superior to them in certain instances. Its good mechanical properties render it suitable where a high tensile strength and elongation and good resistance to wear are required.

The tensile strength of cast Corrix-Metal ranges from 41 to 44 tons per square inch with an elongation of 25-35%. These values both exceed those shown by an American alloy of almost the same composition. The reduction in area, 32·8%, is also high, and the Brinell hardness is 190-195. The alloy can be pressed, rolled, forged, drawn, annealed, hardened, and welded. Its thermal conductivity is rather more than twice that of steel.

A cracker bell 6 ft. 6 in. in diameter has been made from Corrix-Metal for an ammonia saturator working in the heat.

ELECTRICAL DE-TARRING.

H. Eiring, in *Das Gas- und Wasserfach*, 1934, 77, 113-119 (Feb. 24), gives a description of the electrostatic precipitation method for the removal of tar and dust from gases. By this means, practically complete removal of the tar is effected, whereas removal is far from complete in the tar extractors normally used in gas-works. The performance of benzole washers and purifiers is greatly improved when the gas they are called upon to handle is free from tar. The pressure drop in an electrostatic precipitator is very small—namely, from $\frac{1}{8}$ to $\frac{7}{16}$ in. W.G. A table gives particulars of the performance of nineteen Siemens-Lurgi-Cottrell de-tarrers and dust extractors. The examples cover the treatment of coal gas, coke oven gas, carburetted water gas, producer gas from lignite, shale distillation gas, natural gas, and blast furnace gas. The installations are of widely varying capacities—namely, from 280,000 to 5 million c.ft. per 24 hours. The working temperature ranges from 60° to 194° F., and the power consumption from 1·7 to 5·4 KW.H. per 100,000 c.ft. of gas treated. The efficiency of dust or tar removal is generally above 99·5% and sometimes exceeds 99·9%. In Europe and America there are 167 plants of this type, 32 handling coke oven gas and coal gas, 55 carburetted water gas, and 80 producer gas and distillation gas. The total quantity of gas treated exceeds 2,000 million c.ft. per day.

Principles of Gas Lamp Design*

By L. T. Minchin, B.Sc., Gas Light and Coke Company.

The basis of the present day gas lamp is the employment of a light and fibrous structure of thorium and cerium oxides which is heated to incandescence by a bunsen flame burning within it. Doubtless the catalytic combustion on the very large surface of the mantle helps to concentrate the heat liberated by the reaction on to the fabric, but in general it is true that any other form of heating which resulted in the same temperature would produce a similar result.†

It is a mistake, however, to regard the composition of the mantle as a magical formula, which causes it to glow with mysterious intensity quite beyond the wit of man to understand. Rubens[1] in 1906, and Ives, Kingsbury, and Karrer[2] in 1918 have related this property, remarkable though it be, in quite a logical manner to the known properties of the separate oxides and the laws of radiation. Thoria, by itself, has a very low emissivity, and consequently a mantle of thoria will attain a higher temperature than one made of almost any other material placed in the same flame. It will not, however, glow very brightly, since of such radiation as is emitted very little occurs in the visible region of the spectrum. The addition of a minute amount of ceria—say, 0·1%—makes a remarkable difference, since this oxide has a very high radiation component in the green-blue end of the spectrum, and when raised to the temperature of the thoria emits a brilliant white light.

As small successive amounts of ceria are added, the light at first becomes proportionately brighter, but by the time 0·9% has been added, the increased radiation from this amount has commenced to lower the temperature of the mixture, causing the light to become redder in colour. Further addition of ceria will still increase the luminous radiation at a fixed temperature, but in a flame this temperature is dependent on the total radiation of the body, and the fall in temperature now more than outweighs the increased radiating properties of the rising proportion of ceria; and as this is increased further the light becomes still more red and the luminous efficiency still lower. The case might almost be compared to the problem of the oak and the ivy; what proportion of ivy to oak results in the largest total number of leaves?

The researches that have been made since Welsbach's discovery in an attempt to discover some more efficient combination than thoria and ceria have been singularly unsuccessful; thoria with 0·7% of uranium oxide makes a bad second with an efficiency of 50% of that of the ceria composition.[2] Excluding the discovery of a better mixture, therefore, and apart from the possibility of development on widely different lines, the possibilities of improving the efficiency may be summarized as follows:

(1) Raising the temperature. This has a very striking effect on lighting efficiency, as may be shown by admixture of oxygen with the gas,‡ but it seems probable that a higher temperature than that attained in the high-pressure lamp is scarcely practicable, in view of the increase in ceria volatilization which then becomes serious. It might, however, conceivably be possible to replenish this by spraying or immersing the mantle with cerium nitrate at regular intervals, if this problem were to become acute.

(2) Altering the shape or size of mantle so that a bigger area of fabric is obtained, which can be maintained at the same temperature without any increase in gas consumption. Here, of course, necessity for mechanical strength imposes a limitation, even if it should prove possible to obtain any advantage this way.

(3) Reducing the convection, conductivity, and radiation losses. An approximate heat balance for a single mantle is as follows:

B.Th.U. input	100
Lost by flue gases and convected air (including conduction through nozzle)	60
Total radiation	40
Of which radiated as light is	0·2§

Assuming the conduction loss to be very small, it is evident that there is considerable possibility of effecting a saving in energy in the second item. The large amount of non-luminous heat radiation can also be trapped to a very limited extent by a glass globe which absorbs radiant heat and re-radiates it to the mantle.

THE LUMINOUS EFFICIENCY OF GAS LAMPS.

The precise statement of the luminous efficiency of a given make of lamp is fraught with considerable difficulties, and it is really not surprising that absolute figures have been so difficult to obtain. Among the variable factors which influence luminous efficiency are:

(1) Calorific value of gas used.
(2) Gas rate and working pressure employed.
(3) Atmospheric conditions.
(4) Specific gravity and composition of gas (affecting aeration).
(5) Method of expressing efficiency.
(6) Efficiency of particular batch of mantles used for test.
(7) Make of globe used.

Of these variables (1) and (4) are approximately constant for any one laboratory; (2), (3), (5), and (7) can be controlled or eliminated by the observer; but (6) is probably the most troublesome of all, since unless special precautions are taken it invalidates comparison between any two results taken in the same laboratory at different times. This effect is lessened by buying mantles from reliable makers, but the only satisfactory method is to keep a stock of several gross of mantles from the same consignment, and test a representative sample for horizontal efficiency when the batch is received, this efficiency afterwards being quoted on all results. For (1) and (4) they are taken throughout this paper as Gas Light and Coke Company's gas—C.V. 500 B.Th.U. per c.ft. and sp. gr. 0·48. Standard atmospheric conditions (3) are 4·0 grains per c.ft. of water vapour and less than 0·1% CO_2.

Methods of Expressing Lighting Efficiency.

The efficiency of a gas lamp is not usually stated in terms of energy output divided by energy input, partly because this figure (as with all artificial light sources) is somewhat discouragingly low, and partly also because its calculation involves use of the thermal equivalent of light (relation of calories to candle power) the value of which has not been determined to great exactitude.

For most purposes it is sufficient to quote the light output in candle power or lumens and the gas input in thermal units or even in volume of gas of known calorific value.* It only remains to decide how the light shall be estimated—whether total light emission in all directions, or average emission over the lower hemisphere, or even maximum candle power be adopted as the basis of the efficiency figure.

From the point of view of the investigator of light sources there is no doubt that the first of these is the only possible basis of calculation. If, for example, the effect of excess air on lighting efficiency is being studied, only the total light output is of interest; any change in the light distribution is incidental and can probably be easily modified by a slight modification of the reflector. Similarly, if two apparently similar street lamps were compared, the one having the lower efficiency on a total output basis might, as a result of the superheater being a quarter of an inch higher, appear to have a higher efficiency on the basis of lower mean hemispherical candle power (fig. 1).

From the point of view of the utilization of the lamp, however, the lower mean hemispherical candle power is often of much greater importance than the total light output, at least in the case of the lighting of streets or interiors without light ceilings. This question is of particular importance with the gas source, since approximately 70% of the light from a bare mantle is emitted in the lower hemisphere, a figure which compares favourably with the 55%-60% of the standard gasfilled lamp (cap upwards). In consequence of this difference it is obviously inequitable to compare these two sources of light on a mean spherical candle power basis if only the light emitted in the lower hemisphere is to be of use.

* From a paper presented to the London and Southern District Junior Gas Association, March 16, 1934.

† Except in a strongly reducing atmosphere, when the radiation characteristics are entirely changed.

‡ Adding sufficient oxygen to raise the flame temperature from 1,900° C. to 2,100° C. resulted in an increase of 200% in the light output of an upright mantle (Ives, Kingsbury, and Karrer).

§ Several ways of stating this, each leading to widely differing results are possible. It is here expressed as the fraction of total energy input required to produce same candle power, if all energy were radiated at wavelength of 5,000 A (yellow-green). Actually, however, to produce white light all wavelengths within the visible range are necessary, and the maximum theoretical efficiency obtainable from a heated body is 13%.

* Sometimes the reverse—*i.e.*, "heat input per candle"—is used. This has little to justify it, except that it gives figures of a convenient size when B.Th.U. are employed. It is, however, very confusing, since a low figure represents a high efficiency, and the corresponding "watts per candle" has now dropped out of use in favour of "lumens per watt."

The use of maximum candle power as a basis for statements of efficiency has little justification when applied to ordinary lamps, but has been used by the manufacturers

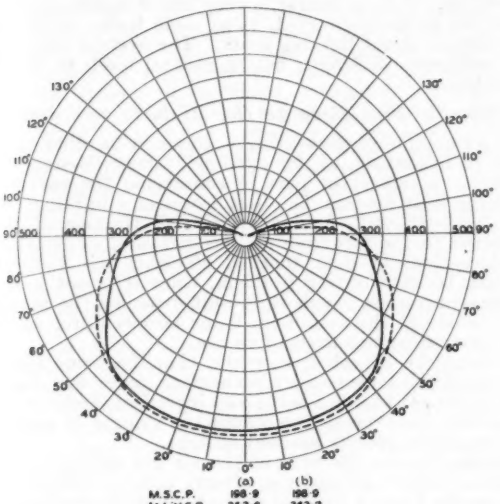


Fig. 1.—Polar curve of 5-light street lamp (a) normal, (b) superheater lowered only ¼ in. to show effect on distribution and on lower hemispherical candle power.

for many years. In almost every case it would be better replaced by mean lower hemispherical candle power both for this purpose and for rating lamps.

Lighting Efficiency Obtainable from Commercial Lamps.

It is of interest at this point to state the magnitude of the efficiency for typical good quality lamps which is obtained in the laboratories at Watson House.

10-lt. cluster lamps using C (No. 2 cluster) mantles—200 lumens per c.ft.

10-lt. cluster lamps using B (long bijou) mantles—235 lumens per c.ft.

using mantles having a horizontal efficiency of over 16 candles per c.ft. when tested on standard domestic burner.

These figures represent "good practice"—*i.e.*, they are the highest achieved commercially at the present day.

INFLUENCE OF LAMP DESIGN FACTORS ON LIGHTING EFFICIENCY.

(i.) Gas Rate and Mantle Size.

As the gas rate of supply to a mantle is increased from zero, the light output increases (usually more rapidly) until a maximum is reached, after which further increase in gas rate only results in the light remaining constant or falling slightly. It is therefore obvious that beyond this bend the efficiency falls rapidly, and in the case of curve (*a*) fig. 2, the maximum efficiency occurs at the same point—*i.e.*,

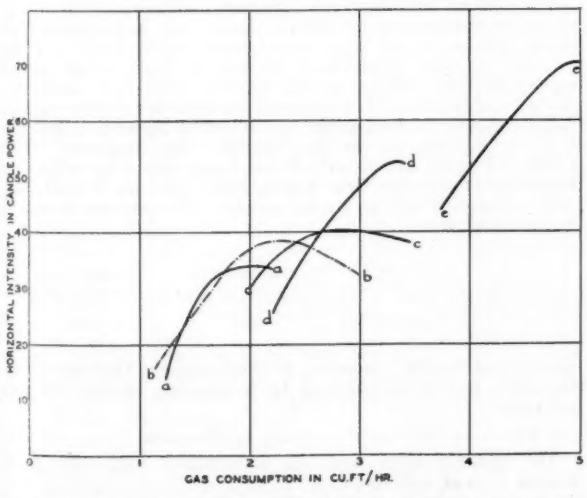


Fig. 2.—Variation of candle power with gas rate for (a) bijou, (b) long bijou, (c) No 2 cluster, (d) medium, and (e) Universal mantles.

1·6-1·8 c.ft. per hour. This is a satisfactory condition, since it means that if the lamp is set to give maximum light for the least gas consumption, the efficiency will automatically be a maximum. It is important to note, however, that the C mantle (No. 2 cluster medium) differs in that the efficiency is a maximum when the lamp is giving well under its maximum light output—*i.e.*, at about 2¼ c.ft. per hour. On an actual street lamp it was found that the maximum output occurred at 3 c.ft. per hour, but only 11% increase accompanied the 25% increase in gas rate from 2·5 to 3·0 c.ft. per hour. This mantle is alone in this property among the sizes generally in use, and it constitutes a considerable disadvantage.

The characteristic curve of a mantle is not quite independent of the type of lamp used, as reference to figs. 2 and 3 will show, but the form is very similar throughout.

The efficiency of a mantle is measured on the basis of horizontal candle power on a domestic burner for the purpose of routine tests, and the following summary of a very large number of tests provides some interesting information as to the relative efficiency of the five sizes in use during that period.

Table I.

Type of Mantle.*	No. of Batches Tested.	Gas Rate of Test.	Average Efficiency.†	
			Horizontal C.P. per C.Ft.	Lumens per C.Ft. (Calculated.)
A (bijou)	115	1·75	16·64	185
B (long bijou). . .	54	1·85	17·00	192
C (No. 2 medium) .	104	2·3–2·5	15·98	170
D (ordinary medium)	66	3·0–3·2	15·95	180
E (universal) . . .	166	4·5–5·0	15·92	171

* For dimensions of these mantles see Appendix.

† These efficiencies are not representative of the mantles as *used* by the Company, but of those *submitted* by manufacturers. The average efficiency is accordingly lowered by inclusion of those samples which were rejected on account of poor light output.

Only by some such summary as this can the relative merits of the five sizes be compared, since in comparing individuals the possibility of a difference in the fabric itself, apart from the size of the mantle, is always present.

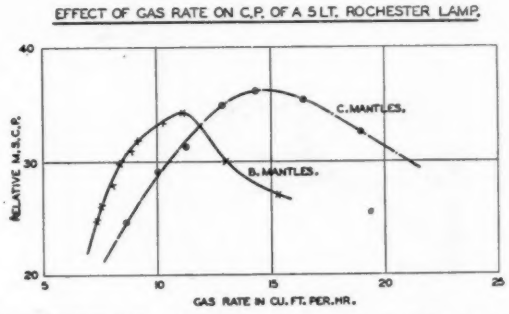


Fig. 3.—Variation of candle power with gas rate for 5-lt. street lamps using B ("long bijou") or C ("No. 2 medium cluster") mantles.

The conspicuous feature of this table is the high efficiency of bijou mantles in comparison with the C mantle which only burns 25% more gas and which has the additional undesirable feature mentioned above that it is normally adjusted to a rate at which the efficiency is still lower. It is to be observed that the difference in efficiency revealed in Table I. is still less than that experienced in high efficiency lamps as mentioned earlier, where the difference is 17%. Fig. 3 shows this effect well, and it will be observed that in this particular case some 8% increase in candle power is obtained at the expense of 30% increase in gas rate by the use of C instead of B mantles.

This being so, there seems to be no doubt that the advantages accruing from the use of bijou mantles instead of "cluster" far outweigh the slightly increased mantle usage.

The effect of alteration in length of fabric seems to be principally that more gas can be used before reaching the maximum candle power as shown in figs. 4 and 5, in which the result of variations of length in the characteristic curve can be seen. These results have been obtained using open-end nozzles or, occasionally, grid-ends; and it must be remembered that if a different type of nozzle were employed, some of these generalizations might be no longer valid.

(ii.) "Superheating."

The principal development since the introduction of the inverted mantle is frequently stated to be the introduction of the "superheating principle." This statement is usually

accompanied by a vague (and almost meaningless) reference to a decrease from 25 to 15 B.Th.U. per candle, which implies 66% increase of light output. This is certainly very misleading, since the difference between the light output of a single-mantle domestic burner and a high efficiency outdoor lamp is not more than 30% of the former, and the proportion which is due to the use of a "superheater" is considerably less. The effect of the use of this feature is threefold: (*a*) The air gas mixture is preheated, (*b*) the mantles are situated close together, and (*c*) the proximity of the superheater to the mantles modifies the light output by absorption and reflection. The combined effect of these three factors is to increase the light output of the mantle

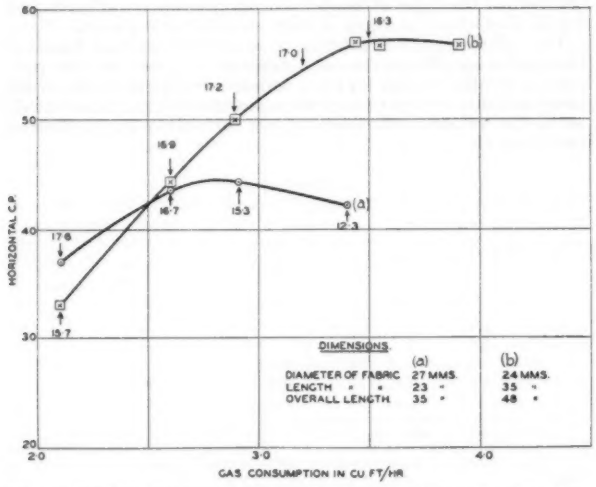


Fig. 4.—Candle power-gas rate curves for two mantles on the same ring and nozzle, but of different length fabric.

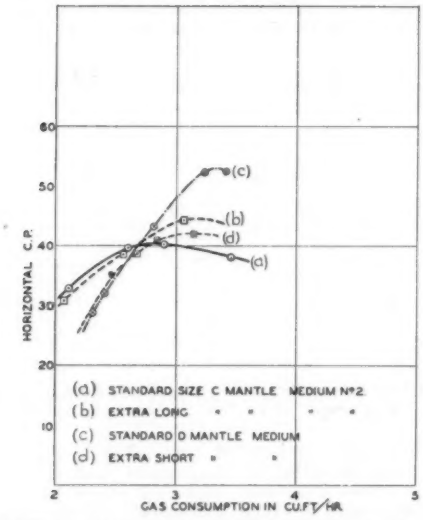

HORIZONTAL C.P.
GAS CONSUMPTION IN CU.FT/HR
(a) STANDARD SIZE C MANTLE MEDIUM N°2
(b) EXTRA LONG " " " "
(c) STANDARD D MANTLE MEDIUM
(d) EXTRA SHORT " "

Fig. 5.—Candle power-gas rate curves for mantles, showing the effect of abnormal variations in length (considerably in excess of specification limits).

by little more than 20% in the commercial forms of superheater; but the amount of light in the lower hemisphere does increase considerably as a result of the alteration in distribution brought about. In addition the intrinsic brightness increases at the same time, and these circumstances have no doubt led to the somewhat exaggerated ideas frequently expressed in the past. Actually, however, the mere expression of its effects in terms of luminous output does less than justice to the superheated burner, since light is nearly always required in the lower hemisphere, and to convert the characteristic distribution of the single mantle to that of the superheated cluster by means of a reflector would necessarily involve a loss of perhaps 10% in reflection losses. By means of this device, however, the change to a more useful distribution is accompanied by an increase of perhaps 20% instead of a loss of 10%.

The effect of the use of the superheated cluster on light distribution has also the important effect that candle power on the horizontal is reduced by the occultation of some mantles at angles above 80° from the vertical, and this fact is probably largely responsible for the lack of glare normally associated with light from these lamps. When a line formation is used in preference to a circular cluster this advantage is lost, without any compensating advantages except perhaps that it "looks brighter" to the inexperienced eye. It is, of course, a very useful construction when light has to be re-directed, as in some forms of floodlamp and certain street lighting units. The over-all efficiency is not materially different, but in general tends to be somewhat lower.

(a) Effect of Preheating Air Gas Mixture.

The principle of preheating is common in other applications than lighting, as, for example, furnace design, where it plays an important part in conserving the energy and reducing heat losses. The heat losses of a lighting burner are, however, 99%—and a very small fraction of this is imparted to the incoming air gas mixture. Furthermore, considerations of pure thermal efficiency are hardly applicable to the lighting problem, since it is not heat but temperature upon which the result depends; the mantle is very nearly at the maximum flame temperature, and heat at a lower temperature is of no use.

It would be expected, however, that the flame temperature would be increased by preheating, since the heat content of the gas supplied is thereby increased, and this might reasonably be expected to reduce the volume of gas necessary to give a definite amount of light.

Taking the specific heat of the air gas mixture as 0·018 B.Th.U./c.ft./° F. and the air-gas ratio as being 2 : 1 it will readily be seen that the extra heat input resulting from a rise of 100° F. is (total volume) × (sp. ht.) × 100 = 5·4 B.Th.U. per c.ft. of gas or just over 1% of the heat input. This represents the minimum light increase to be expected; but if the temperature is increased, other conditions remaining the same, 1% rise in heat radiated from flame should represent $\sqrt[4]{0{\cdot}01}$ increase in the absolute temperature and $(\sqrt[4]{0{\cdot}01})^{12 \text{ or } 16} = (0{\cdot}01)^3$ or $(0{\cdot}01)^4$—that is, 3 to 4% increase in the light.

Early experiments to verify this gave misleading results on account of the increase in resistance of the burner and consequent fall in aeration resulting from the expansion of the primary mixture. It is too early at present to place reliance on subsequent results obtained with an improved burner so that optimum aeration could be attained, but up to the present the above rough calculation has been confirmed.

Temp., ° F. of Air Gas Mixture.	Efficiency (Lower Hemisphere).
327	100
400	103
500	106
600	109
(700)	112

i.e., 3% per 100° F. rise.

In the single experiment from which the above results were taken, the temperature was taken up to about 700° F. without the curve appearing to "flatten out" at all, but considerable difficulty is liable to be experienced at the higher temperatures with the flame partially lighting back.

Evidently at some temperature the increased flame velocity and the tendency for combustion to take place before reaching the nozzle will make a low-pressure burner unworkable, but there is no indication that that point has been approached in commercial lamps.

The extent to which the foregoing considerations affect the performance of an actual lamp was investigated in connection with an iron superheater taken from a commercial 5C (No. 2 medium cluster) outdoor lamp which was compared with a domestic burner (with very small deflector only) which was adapted to take the same nozzle. A base-metal thermocouple was inserted through a hole in the nozzle just above the mantle lug supports. The original burner taken out of the lamp was used with the superheater and the same five mantles used on it were also used separately on the single burner. The results obtained were as follows:

—	Single Burner.	5-Light Burner
Light efficiency	100	120
Temperature of air gas mixture	490°	670°

So that, of the 20% increase, it would appear that not more than 5% can be attributed to preheating of the air gas mixture.

(b) Effect of Mutual Proximity of Mantles.

The mantle loses heat in accordance with the well-known law of radiation:

$$Q = E\,(T_1^4 - T_2^4)$$

where Q = quantity of heat lost, E = total effective

emissivity, T_1 = Abs. temperature of radiator, and T_2 = Abs. temperature of surroundings.

In the case of a mantle burning without globe in an ordinary room, T_1^4 is of the order of 2×10^{13}, and T_2^4 approximately 8×10^9, so that the latter expression need not be considered. When, however, this mantle is surrounded by globe, reflector, and superheater all raised to a considerably higher temperature than the room, T_2^4 begins to become of sufficient magnitude to cause a perceptible rise in T_1^4 or a fall in Q. Assuming, however, that Q bears a fixed relation to the heat input of the burner,* the maximum rise in T_1 which will result can be easily computed. If the globe be at 200° C., the internal reflector 300° C., and the superheater at 400°, T_2^4 causes an increase of 0·6% in T_1^4, which—assuming the light output proportional to the sixteenth power of the temperature—represents an increase in light of 2·7%. If the whole surroundings were at 400° C. the figure would be 6%, so that little can be gained this way, particularly as the absorption of good clear glass amounts to several per cent.

If, however, the case of two mantles slowly brought together be considered, it is evident that a definite percentage of the surroundings of each mantle radiates at the same rate as the mantle itself, and it is therefore not surprising that an increase in temperature and consequently of light output results. At the same time, however, the mantle is obstructing the light of its fellow more and more, so that on this ground the total light tends to decrease.

Using a three-armed burner in which the mantles could be moved nearer together or further away, the results shown in fig. 6 were obtained for the maximum horizontal C.P. (*i.e.*, at right angles to the line joining the mantles) and the total light output as measured in an integrating cube. These results provide useful information as to the optimum distance apart, but the actual values of the increase obtained are only true for three mantles in line formation, and consequently cannot be applied directly to the problem of the 5-light superheater mentioned in the previous section. In the 3-light line burner one mantle receives radiation from two others, and the remaining two from one; whereas in the 5-light cluster each mantle is exposed to radiation from two near mantles and two further ones. This, in part, explains why the percentages shown in fig. 7 fall so far short of the 15% required to account for the 20% increase in flux resulting from the use of the 5-light superheater.

Later experiments, since this diagram was made, indicate that with the B (long bijou) size up to 20% increase of the horizontal candle power can be obtained; and it is this latter figure which is chiefly important when the maximum candle power obtainable in one direction is to be considered. An increase in the intrinsic brightness of the mantles effects a corresponding increase in the maximum candle power obtainable from a given mirror reflector, as will be shown in a subsequent section, and it is quite evident that this effect of mutual proximity is one of the important factors in the advantages claimed for the superheated burner.

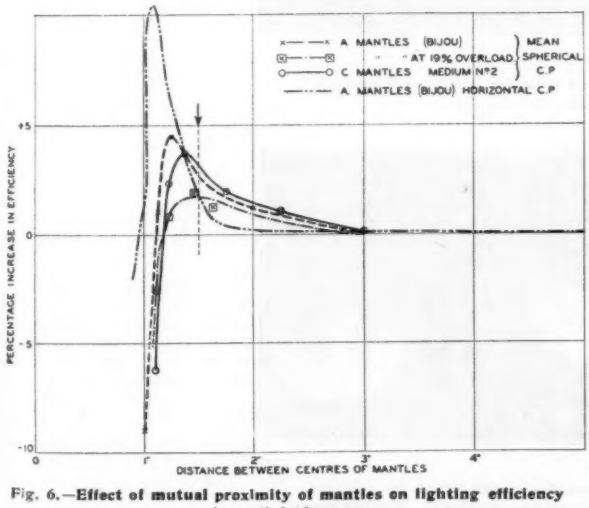


Fig. 6.—Effect of mutual proximity of mantles on lighting efficiency for 3-light burner.

* Actually heat input to burner and radiant heat output of mantle are not in constant ratio if temperature varies widely. Ives, Kingsbury, and Karrer have shown that the total thermal radiant efficiency of an iron impregnated mantle is higher than the Welsbach mantle on account of the lower temperature and consequent steeper temperature gradient between flame and mantle.

(iii.) Effect of Flame Shape and Aeration on Efficiency.

The interaction of the combustion gases which form flame and the solid network which constitutes a mantle is a subject of considerable complexity and one of great importance to the theory of the gas lamp.

Before the mantle is fitted, the flame from an open end E nozzle is some 2-2½ in. long with a cone ¾ in. long and ⅜ in. wide at the base; and the space between the surface of the inner cone and the outer boundary of the flame is filled with carbon monoxide, carbon dioxide, hydrogen, and water vapour in equilibrium resulting from the interreaction between gas and the oxygen in the primary air.

If a mantle is now put on the nozzle, the inner boundary of the combustion zone remains practically constant, but the outer boundary alters entirely, becoming now almost identical with the shape of the mantle, although actually the combustion is not completed until two to three millimetres beyond the fabric, and 1-2% of carbon monoxide remains uncombined on the mantle surface (figs. 7 and 8). In addition to this film of flame round the mantle, a very faint blue flame can be detected about 1 in. long above the mantle ring. This is very noticeable when working with iron-impregnated mantles, but it is surprising to find that it exists to a similar extent in the normal mantle, and can be seen when the light is carefully screened from the eye.

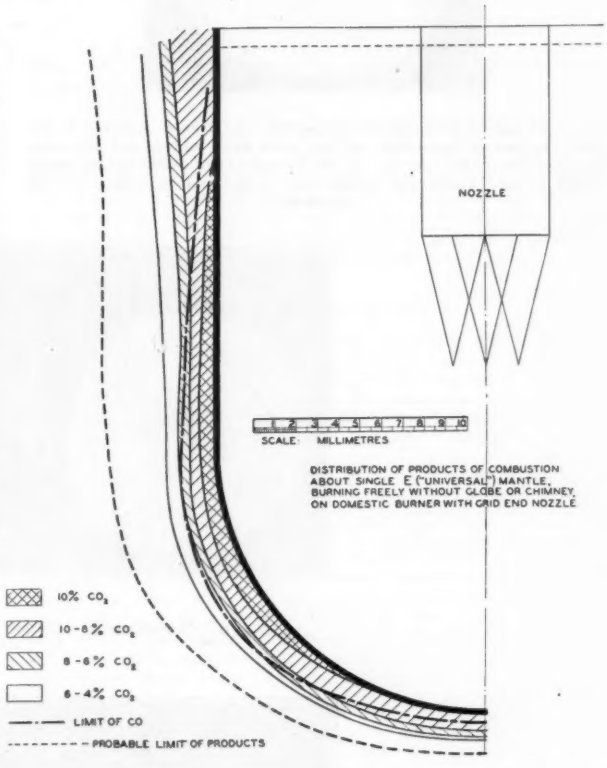

NOZZLE
SCALE: MILLIMETRES
DISTRIBUTION OF PRODUCTS OF COMBUSTION ABOUT SINGLE E ("UNIVERSAL") MANTLE, BURNING FREELY WITHOUT GLOBE OR CHIMNEY, ON DOMESTIC BURNER WITH GRID END NOZZLE
10% CO2
10-8% CO2
8-6% CO2
6-4% CO2
LIMIT OF CO
PROBABLE LIMIT OF PRODUCTS

Fig. 7.—Distribution of products of combustion about single E ("Universal") mantle without globe or chimney, showing relative position of nozzle and inner cones. Gas rate 4·8 and optimum air adjustment.

The reason for these changes in the outer boundary of the flame is evidently the resistance offered by the fabric, since even the products do not penetrate far below the bottom of the mantle. (Fig. 7.) It is highly probable that the fabric exerts a catalytic action in hastening the completion of combustion—indeed, it is easy to demonstrate that Welsbach mixture will catalyze this reaction, and in any case it is hard to believe that any solid at that high temperature would not act as a catalyst. In this connection the extremely open fibrous texture, exposing a very large surface area, also suggests that catalytic action is responsible for the high temperature imparted to it by the flame, although as demonstrated as long ago as 1898 by Le Chatelier and Boudouard,[3] it does not account for its unusual radiating properties at that temperature.

Effect of Shape of Inner Cone.

The outer flame boundary is doubtless very important, especially in connection with secondary air, in which connection it is discussed in a succeeding section. The primary aeration is, however, directly related to the shape

of the inner cone, and the angle between the base and the side bears a mathematical relation to the air-gas ratio.[4] It is observed that in the case of an open-ended nozzle the maximum candle power invariably coincides with an adjustment such that the point of the cone just touches the bottom of the mantle. If the cone is made shorter by increasing the aeration, the lower section of the mantle becomes duller, the top of the creases being darkest of all; if the cone, on the other hand, is made longer, it

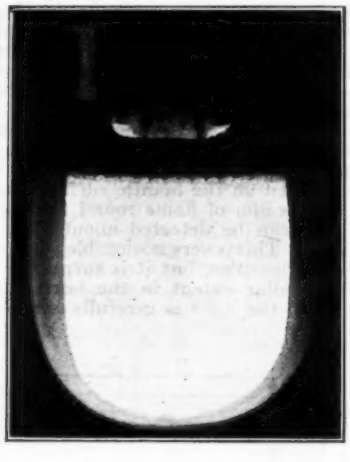


Fig. 8.—Limit of products of combustion on normal mantle. A few small crystals of potassium chloride have been added, and the outer line shows the limit reached by the vapour. The flame sheath (made visible by the violet and ultra-violet potassium radiation) is also discernible.

projects on to the bottom of the mantle, forming a black spot on which the troughs of the creases are darkest. The characteristic appearances of under and over aerated flames are useful to note, and they are illustrated in fig. 9.

It is not easy to see why this generalization should be true; since it would appear that unburnt gases from the apex of the cone would then pass through the fabric before combustion occurred; and actually a comparison of the outer flame boundary in fig. 10 reveals that the flame film at the bottom of the mantle is thicker in this case than in that of the other nozzles, in which maximum candle power occurs when the cone is considerably shorter than the mantle.

It is evident, therefore, that the shape of the inner cone exercises an important influence on the subsequent distribution of temperature and composition in the combustion space. The effect of nozzle shape on lighting efficiency with standard mantles has been determined practically and can be summarized as follows:

Open end nozzle	100
Pepper-box type	approx. 90
Grid-end type	,, 110

It is found, however, that the exact proportioning of the holes in the grid-end nozzle has a bearing on the light output, and for the E mantle ("universal") on domestic burner the best shape appears to be—

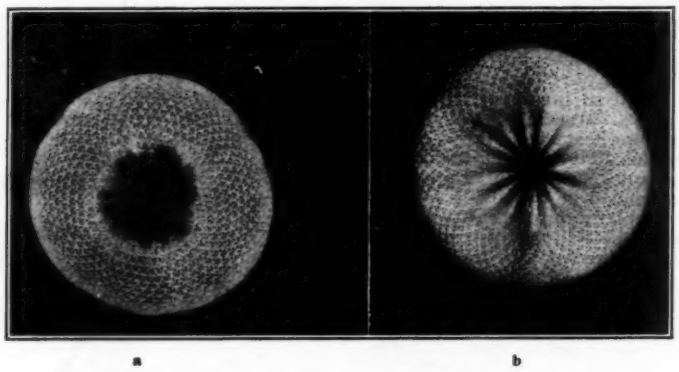
Diameter of centre hole	0·175 in.
Width of outer holes (*i.e.*, minimum dimension)	0·103 in.
Thickness of wall	0·05 in.

It is difficult to see why this type of nozzle should not be universally adopted, since the somewhat greater noise obtained when used without gauze or disc can be prevented by other means.

(iv.) Volume and Temperature of Secondary Air.

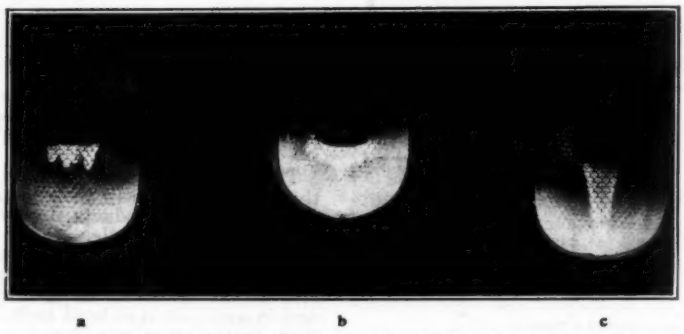
It is a sound general principle in the design of gas appliances that the volume of excess air passing through the appliance must be maintained sufficient to allow an overload without smothering, but, on the other hand, kept as small as possible so that the chilling effect of the cold air is minimized. This principle has been applied with success to water heaters of many kinds, cookers, furnaces, and gas fire radiants, but lamps—in which high efficiency is so essential—seem to have been neglected.

Excess air can be divided into two parts—that which



a b

Fig. 9.—Characteristic appearance of (a) under and (b) over aerated flames.



a b c

Fig. 10.—Shape of flame in and around the mantle when (a) grid end, (b) "pepper box," and (c) open end nozzles are employed. Mantles have been rendered non-luminous, by being impregnated with a salt of iron.

misses the combustion zone entirely, and that which actually passes through, and chills, the flame. In the experiments about to be described the chimney is so constructed as to reduce the former part to a minimum, and the fact that perfect combustion can be obtained at the theoretical air rate, shows that this has been achieved.

The apparatus consists essentially of a 3A (bijou) clay superheater, surrounded by a globe, the edge of which beds on to an asbestos-lined flange so that air cannot be

drawn in unmeasured. A large diameter tube, lagged on the outside, leads into the bottom of the globe and air passes by this from the meter and preheating coil to the burner. Both temperature and volume of secondary air, and also gas rate were varied, always keeping the primary aeration at the optimum, and the light output was measured by means of a Weston photo-electric cell which received light from an opal glass sheet exposed to the radiation at angles between 90° and 45° from the vertical.

A long series of experiments revealed the following surprising facts:

(1) Maximum light output occurs when secondary air is about twice that required for complete combustion.
(2) The volume required to give maximum light output is practically independent of temperature (volumes being measured at room temperature).
(3) The effect of increase in temperature of secondary air on lighting efficiency is very small—not more than 3% for an increase from 200° to 400° F.
(4) Visual observations on an iron impregnated mantle showed, and analysis of gases of flame on ordinary mantles confirmed, that the increase in secondary air from theoretical requirements to maximum light output is accompanied by a shrinkage in the thin blue film of flame surrounding the mantle.

The effect of increased secondary air seems, therefore, to be to accelerate the combustion on the surface of the mantle, or possibly merely to blow it back on to the mantle, but in either case to increase the temperature and hence the luminosity of the mantle. This effect is in the reverse direction to the chilling effect which would normally be expected to reduce the efficiency, and is an increase in spite of the 30% heat required to heat up the extra 2½ volumes of air to flame temperature.* It would appear that if some form of gas light could be found which would operate at the minimum secondary air flow required for complete combustion, a considerable increase in efficiency could be obtained.

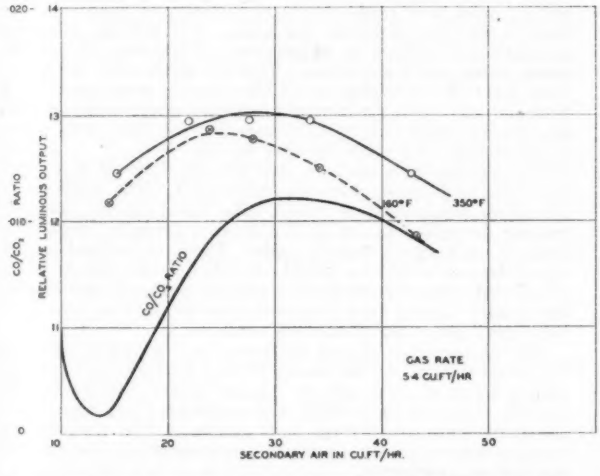


Fig. 11.—Effect of secondary air on (a) lighting efficiency at two temperatures and (b) combustion efficiency. The theoretical secondary air requirement for complete combustion is about 13 c ft. per hour.

In fig. 11 are shown two curves of this kind, together with a third curve showing the CO/CO_2 ratio which, although very low throughout, has a maximum roughly at the same point as the maximum light output. This curious increase in carbon monoxide with aeration has been also observed in certain gas fires, where it is likewise found that the primary aeration which gives the highest radiant efficiency—*i.e.*, when the flame is burning just inside the radiant—also gives the highest carbon monoxide concentration in the products; still, of course, extremely small and only of theoretical importance.

The visible effects of increased secondary air are principally an increase in the "over-aerated dark spot," and at the same time a curious wavering motion on the surface of the mantle commences which eventually, at very high air rates, becomes a serious flickering accompanied by a brown appearance in the mantle. At the minimum air rate for complete combustion the mantle is perfectly steady, but less efficient than in the slightly flickering stage in which it is normally employed.

* Assuming all the air to be heated to maximum temperature of flame—i.e., 1,800° C. (approx.).

There appear to be no published scientific data on the increase obtainable from preheating secondary air, in spite of the number of lamps the design of which has been based on this assumption. The actual heat input involved by raising the temperature of the secondary air by 500° F. is only 4% of the total heat input of the burner, and it is possible that this is swamped by the much greater effects referred to above.

The observations on the volume of secondary air is necessary for maximum candle power have, however, been confirmed to a limited extent on an actual lamp; but in this case the optimum excess air was much higher, presumably on account of the considerable proportion which misses the combustion zone entirely. Thus the normal CO_2 concentration from a 5-light outdoor lamp is some 4·25% (7.7 volumes excess air/volume of gas), and any attempt to close the air supply and reduce this is accompanied by an immediate fall in light output. Similarly, by varying the size of the hole in the globe of this lamp, the following results were obtained:

Diameter of Hole.	Relative Efficiency.	CO_2 %.
1½ in.	95	
1 ,,	100	4·12
¾ ,,	109	
½ ,,	114	
¼ ,,	122	
0 ,,	117	4·34

from which it will be seen that quite a marked maximum occurs at ¼ in. diameter hole.

LIGHT LOSSES IN LAMP CONSTRUCTION.

Turning now to the problem of utilizing the light obtained from the mantles in a lamp, it is found that there are several sources of loss of light which are not always recognized as such by the lamp maker. In some cases the effect on the maximum candle power may be negligible, but any factor which tends to increase the total flux produced should be considered.

(i.) Dark Spaces in Lamps.

Any part of the interior of the lamp on which light is incident should be a smooth reflecting surface (absorbing as little light as possible). Thus, for example, the flue space is frequently very much larger than is necessary, and even when the inside is white enamelled a considerable amount of light may still be lost. Similarly, globe rings of rough cast brass may absorb a perceptible amount of the light output. The ribs of an old-type street lamp are, of course, generally known to reduce the light output, and similarly a dark-coloured canopy or gallery may affect an indoor lamp. This factor is particularly important when opal glass is used, as in this case considerably more light is usually thrown on the upper parts of the lamp. If there is a large canopy of, say, copper, a superheater of cast iron, and an unnecessarily large flue space, even the best opal glass will still show a high absorption. The use of white magnesia or clay superheaters in place of the usual cast metal ones has been known to result in a considerable increase in efficiency when a very small silica globe was being employed.

(ii.) Absorption by Glass, Silica, &c.

It is well known that when a ray of light strikes a transparent or translucent material the light is transmitted, absorbed, and reflected in varying proportions depending on the nature of the material and the angle of incidence.

Clear Glass.—At normal incidence the transmission of clear glass globes is very high, about 95%, being 1 or 2% less in thick heat-resisting glass than in the clear glass, but this is of little importance. The chief point of interest is that the reflected component increases rapidly with the angle of incidence, so that light should be made to pass through the glass as far as possible perpendicularly.

Opal Glass.—In the past, opal glass was only used in gas lamps at the expense of a great loss in efficiency, unless used solely as a reflector. Sample lamps tested have had as low as 45% efficiency, and under these conditions clear or frosted glass was much more general. Recent advances in glass-making technique, however, have made a heat-resisting opal available which, under suitable conditions referred to above, will transmit 75% of the light without the shape of the light source being visible.* This high efficiency is only obtainable by multiple internal reflections, so that any absorbing

* This, however, depends upon the shape of the globe—see B.S.I. draft specification on Translucent Glassware Illumination Fittings.

material inside the lamp will reduce this, and the transmission of a single plane sheet may not be more than 50%.

Silica.—Fused silica, of the opalescent variety, is frequently used in gas lighting appliances on account of its extremely good heat-resisting properties, and its characteristics are similar to opal glass. The efficiency, however, is considerably less, a straight cylinder only transmitting 65% of the light from a 5C cluster.

Frosted Glass.—Scatters some light but still leaves a bright spot in a line with the mantle. It is difficult to maintain clean, and has the additional disadvantage that it looks grey in colour when the lamp is out.

Prismatic Glass.—May be used to transmit and deflect light in a given direction, to transmit and scatter light, or to reflect regularly, and all three types are capable of being used in design of gas lamps. The amount of light lost by absorption is very low—the refracting bowl used for street lighting absorbs 4%—but some light is lost by scattering from the prism edges.

(iii.) Reflectors.

When specular properties are not required, white enamel is invariably the best material, since it has a reflection factor of 70% and is easy to clean. Considerable variations in white enamel occur, however, as a result of varying opacity of the thin film of glass which is the reflecting medium. When this is thin, some light penetrates to the black surface of the steel, and careful examination and comparison of samples will reveal a greyish appearance, which may mean a loss of 10% or more of the light incident upon it. If specular properties are required, staybrite (50%), chromium plate (60%), or mirror glass (85%) may be used. An alternative form of reflector is moulded prismatic glass, and in this case the proportion of reflected light to transmitted light can be varied by rounding the edges of the prisms.[5]

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Malleable Iron Fittings for the Gas Industry

On Wednesday, March 14, members of the London and Southern District Junior Gas Association were the guests of Messrs. Crane, Ltd., at their works at Ipswich, and an interesting day was spent inspecting one of the most up-to-date factories of its kind in the country, having what is claimed to be the biggest output of malleable iron fittings in addition to the manufacture of radiators, boilers, gunmetal and cast-iron valves. The Gas Industry is, of course, one of Messrs. Crane's largest customers.

Messrs. Crane, Ltd., have long recognized the necessity of scientific control at every step in the manufacture of their products, and all raw materials entering the works are subjected to careful tests before they are utilized. Not only are all raw materials carefully analyzed and tested, but hourly tests are carried out on almost every process throughout production.

The laboratories include up-to-date equipment for the examination of metals under the microscope, which enables the metallurgist to ascertain if the heat treatment or annealing of the malleable casting has been carried out satisfactorily. Another use of the microscope is in the examination of pipe and fitting threads and joints, and a perfect metal-to-metal joint is claimed with taper threads.

Dealing first with the foundry, it was noticeable how the old methods have given way to modern scientific thought and engineering skill in the ingenious mechanical devices and costly and complicated plant adopted. All the machines in this department used for sand conditioning, moulding, and metal carrying, &c., have been specially designed to suit the particular product, enabling a continuous system of working to be developed. The waterway in the fitting is produced by independently made sand shapes, which are placed in the mould before the two halves are united. Cores are made from a different quality sand to that used for moulding; a mixture of silica sand, linseed oil, and paste of a resinous nature is made in a rotating mill. The cores, having been moulded in metal shapes, are arranged on portable racks, which are conveyed to ovens where the cores are baked for a period of approximately one hour. Before finished cores are taken to the foundry, they are carefully trimmed, gauged, and inspected to ensure a smooth, clean interior to the finished casting.

The castings coming from the foundry are separated from feeders and runners and loaded into rotating barrels, where they are rotated for a period of 45 minutes to remove the adhering sand, and those that are sound in every respect after a further inspection are packed into pots ready for the annealing heat treatment.

The metal at this stage of production has a high percentage of carbon and is of a brittle nature. The special composition of metal is particularly suited to conversion into a homogeneous malleable iron by the annealing process.

Annealing is carried out in pots placed in a heavily constructed firebrick oven or housing, each oven being capable of holding 40 tiers of pots—an equivalent of 15 tons of fittings. The annealing cycle consists of slowly heating up to a given temperature, maintaining that temperature for a number of hours until the contents of the oven become uniformly heated, when the heating is then stopped and all sight holes, oven doors, &c., are sealed with clay so that the cooling may be gradual. The complete annealing cycle occupies seven days, during which period constant control of the temperatures of each oven is maintained by automatic recording pyrometers.

After a severe test of the malleability of the fittings from each pot, the casting is now ready for the final preparation of trimming to remove projections, cleaning off the discoloration caused by the annealing, and straightening in hand or power driven presses, prior to passing on to the tapping and screwing department.

All galvanized products are galvanized by the hot dip process, each casting receiving a generous and thorough protective coating of practically pure zinc.

In the tapping and screwing department special machines have been designed for the production of fittings complying with the British Standards Institution specification, and these machines are so automatically controlled as to render them practically foolproof. Finally all fittings are varnished as a rust preventative.

The final stage of the production of the pipe fittings has now been reached, and although every care has been taken in the various departments contributing to the manufacture, and many inspections and checks made, the finished article must now pass a very rigid test and inspection before it can be released for sale. Air testing machines subjects the fittings to a pressure of 100 lbs. per sq. in. when submerged in water. The strength of a fitting to withstand the screwing in of the pipe is investigated. A test actually witnessed by the visitors demonstrated a fitting which failed only at the enormous pressure of 2½ tons—or something like 6,000 lbs. per sq. in.

The various processes in the manufacture of the firm's radiators and boilers were also witnessed. The melting and moulding equipment is practically identical to that previously described in the malleable iron foundry, though, of course, on a much larger scale. Each individual section of all sizes of radiators and the finished article are tested to a hydraulic pressure of 100 lbs. per sq. in., and the radiators are finally dipped in a heat-resisting protective coating of light grey paint on all outside surfaces.

The visitors also viewed the power house and the packing department, and in the latter it was noticed that consignments awaited despatch to almost every quarter of the world. The works include a warehouse so designed that all stock bins are within easy reach of the packers and contain approximate quantities representing six months' normal requirements.

A Vote of Thanks.

The Association were entertained at luncheon at the Great White Horse Hotel, Ipswich, Mr. G. C. Detlefsen, Superintendent of the Works of Messrs. Crane, Ltd., presiding.

The Chairman extended a very hearty welcome to the Association and complimented them upon the excellent turn-out of members. Visits such as these, he said, had not only educational value, but also helped to create that happy personal relationship between the Gas Industry and the manufacturers of plant and appliances.

Mr. H. C. Sims (President of the Association) proposed a hearty vote of thanks to Messrs. Crane, Ltd., for their hospitality, and complimented the firm upon the lay-out of their works and machinery, all of which lead to efficiency and saving of labour, while he also referred to the absence of smoke and dirt in connection with the plant.

Mr. F. C. Smith (Senior Vice-President) seconded the vote of thanks, remarking that it was not, perhaps, sufficiently recognized what the Gas Industry owed to the very close co-operation which existed between them and the contractors who supplied them with the articles they required. It was only five years since Messrs. Crane, Ltd., really commenced production, and what had been effected during those five years was a matter for congratulation to those responsible.

Brighton, Hove, and Worthing Gas Bill

House of Commons Committee.—Thursday, March 8

(*Before Mr.* DAVID REID (*Chairman*), *Mr.* DAVID DAVIES, *Lord* FERMOY, *and Capt.* NORTH.)

The Bill of the Brighton, Hove, and Worthing Gas Company, which provides, by means of the clause now becoming common, that housing authorities within the Company's area of supply shall not impose restrictions upon the tenants of their houses as to the form of light, heat, and power they should use, was considered by the above Committee of the House of Commons on Thursday and Friday, March 8 and 9.

The Company was represented by Mr. W. E. Tyldesley Jones, K.C., Mr. F. J. Wrottesley, K.C., and Mr. H. Royston Askew.

There were objections by the Brighton Corporation (represented by Mr. Maurice Fitzgerald and Mr. Willis); and by the Portslade U.D.C. (represented by Mr. Edgar Macassey).

Mr. TYLDESLEY JONES, in his opening address, pointed out that the Company, which was incorporated in 1839, had spent £1,411,000 on the undertaking, and had 80,000 consumers. As showing the importance of the Company as a ratepayer, he said that in 1933 it had paid £4,317 in rates to the Brighton Corporation and £6,098 to the Portslade U.D.C., in whose area the works were situated.

The Company supplied within the areas of ten local authorities and two county councils, all of whom were affected by the Bill; yet only two had objected.

In 1926, the Brighton Corporation had acquired the Whitehawk Estate, and in 1927 had entered into an agreement with the Gas Company by which the latter had bound itself to lay mains in certain streets. There was no obligation on the residents to take gas, and all that the Company had stipulated was that the residents should have freedom of choice as to the media they used for light, heat, and power. When the first 60 houses were built, gas was provided for use in them; later, a further 208 and 56 houses were built, and agreements embracing the same terms were entered into with regard to them.

In 1930, the Corporation had acquired land adjoining the Whitehawk Estate, in order to extend its housing programme. Apparently, as the result of a report from the Borough Electrical Engineer, it was decided that the houses on the extension should be all-electric, and subsequently the Company was informed by the Borough Surveyor's Department that it would not be permitted to lay mains there. The rents of the houses were to be 12s. per week, *plus* 2s. 6d., the latter figure covering the electrical equipment. Of the 2s. 6d., the rental for the electrical apparatus (electric cooker, wash-boiler, kettle, and iron) was 1s. 1d., and the standing charge for the supply of electricity was 1s. 5d. If a consumer wanted a radiator he must provide it himself.

The CHAIRMAN asked if the 2s. 6d. could be recovered by distraint.

Mr. TYLDESLEY JONES replied that it could, because it was part of the rent.

The all-electric policy was also extended to another estate, known as Tarner's Land.

Counsel then referred to the minutes of the Corporation's proceedings, indicating that in March, 1932, a letter was considered from the Kettering Council with regard to giving financial support in the proceedings against the Kettering Gas Company's Bill (the first Bill promoted containing a clause to prohibit a housing authority imposing restrictions on tenants as to the form of heat, light, and power they used). The matter was considered by the Lighting Committee at Brighton, and it was agreed to contribute a sum not exceeding £25. The Gas Company had then written a letter protesting against the resolution, and pointing out that it was *ultra vires*. The correspondence with regard to the matter, said Counsel, indicated that Kettering was to be supported at the instance of the Electricity Committee, but that municipal corporations generally were not prepared to take action in supporting the Kettering Council's action in this matter.

THE ALL-ELECTRIC POLICY AT BRIGHTON.

The reason why the all-electric policy was adopted on the Brighton housing estates referred to was not a question of the terms offered by the Gas Company, because the Company had asked on what terms and conditions it would be permitted to supply gas, and the reply was that the all-electric policy was decided upon.

The position was that the Council had erected on the Whitehawk Estate extension 851 all-electric houses, on Tarner's Land 110, and on the Rottingdean Estate 30, a total of 991. The tenants had to pay for electricity, whether they used it or not. Legally the tenants were not debarred from using gas, but there was in the minds, not only of the tenants, but of the Corporation's officials, the impression that it was a condition that only electricity should be used. If a tenant had a gas supply installed, he had still to pay the electricity charges; the Corporation refused to take away the electric cooker, so that if a tenant wanted a gas cooker he had to have both in his small kitchen, and there was little room for anything else.

There were four stalwarts who were using gas; they were employees of the Gas Company, and Counsel exhibited photographs of their sculleries showing the electric and gas cookers installed side by side, the dimensions of the sculleries being 9 ft. 4 in. by 7 ft. The tenants had written to the Corporation officials, asking that the electric cookers be removed, but they were informed that the Housing Committee were not prepared to grant the request or to vary the conditions of the tenancy, though it could be arranged that they could have houses fitted with gas. But the point was, said Counsel, that none of the houses fitted with gas was available, and in any case the tenants, if they did move to such houses, would be a long way from their work

Since the charge of 2s. 6d. per week to tenants of the all-electric houses was first made, it had been reduced to 2s., because the wash-boilers were transferred to the Housing Committee, and the Electricity Department was relieved of the capital debt in respect of those boilers. A gas company, however, had to cover the cost of its apparatus in its charges, and if the charges of an electrical undertaking had not to cover its apparatus, then it had an advantage in competing with gas.

Of the 74 members of the Council, 65 used gas in their houses and 9 did not; of the 14 members of the Electricity Committee, 9 used gas in their houses and 5 did not.

Counsel said he gathered the Committee was being asked by Brighton and Portslade to re-consider the whole principle underlying the Bill.

The CHAIRMAN said the House of Commons had already laid down the principle. He believed the point was whether the circumstances of this case were such as to provide an exception.

Mr. FITZGERALD (for the Brighton Corporation) remarked that he hoped the Committee would keep an open mind until they had heard his case. Parliament had laid down the principle previously as applying to the facts of the particular cases considered.

The CHAIRMAN said he thought Parliament had gone further than that. However, the Committee had yet to hear the case for Brighton.

Mr. JONES urged that the question of whether the principle ought to be settled in a Private Bill had already been debated in the Kettering case. The principle had been opposed from time to time by local authorities owning electricity undertakings, local authorities with no electricity undertakings, local authorities which imposed restrictions, and local authorities who had said they did not impose conditions, and, therefore, they should not be subject to the provisions of such a Bill. The argument that it should not apply to other lands than housing estates had been debated, and it had been applied to other lands.

Discussing the petitions, Counsel said there was nothing in the Bill which would make it necessary for the Corporation to pipe its houses for gas.

Mr. FITZGERALD said he did not accept that.

Mr. JONES replied (amid laughter) that he was pleased to hear that that was a possible construction, and he hoped the Town Clerk would accept that view if the Bill were passed.

In the Brighton petition it was stated that the prospective tenants of the houses, almost without exception, preferred electricity, and that that was generally the case throughout the country. Mr. Jones pointed out, however, that on one estate there were 200 people who wanted gas. The Corporation were getting precious near inserting an actual term into their agreements that the tenants should not use gas.

With regard to the Portslade U.D.C., he did not see why, when they said they did not intend to impose restrictions, they should brief Counsel in order to say that they should still be allowed to do so.

The CHAIRMAN asked whether, if the Bill were passed, it would still be open to a local authority to decide what should be installed in the houses.

Mr. JONES said it would, and there was nothing in the Bill to compel a local authority to pipe houses. If a tenant wanted his house piped for gas, and could not afford to pay for it, he must make arrangements with the Gas Company. But the Gas Company must have some security, and required the consent of the landlord before spending money on a house. No gas company would install pipes at the request of a weekly tenant if the landlord could give that tenant notice to quit a week after and appropriated the pipes. The Bill was purely negative, merely preventing a local authority from restricting the tenants with regard to the use of gas or other fuel. The tenant, if he wanted gas, had still to arrange for piping, and the Bill might be ineffective if a house were not piped.

The CHAIRMAN asked if there were nothing in the Bill which imposed expenditure on the local authority.

Mr. FITZGERALD said it was his intention to show that the

passing of the Bill would involve local authorities in considerable expense.

Mr. JONES urged that there was nothing in the Bill which imposed upon a local authority the obligation to spend a farthing.

A number of tenants then gave evidence.

THE SLOWNESS OF ELECTRICITY.

Mrs. *Wickenden* (a tenant on the Whitehawk Estate) said that if she could not be provided with gas she could not stay on the estate. She came home from work at about 12 noon each day, and sometimes the children had had to go back to school without dinner because she was not able to cook it quickly enough by electricity.

Mr. *A. H. Milton* (another tenant on the Whitehawk Estate) said that it took from 10 to 12 minutes to boil half a pint of milk in a saucepan by electricity.

GAS SUPPLY AN ESSENTIAL.

Mr. *T. R. Braybon* (who is concerned with building and estate development) said that of 1,900 houses for which he had been responsible, only 81 were all-electric; in the remainder, gas was used, but not necessarily exclusively. In his experience, a supply of gas was necessary.

Cross-examined, he said that less than 10% of the 1,900 houses were sold at less than £500. All-electric houses did not sell as well as those which had gas supplies.

Mr. *L. H. P. Meyer*, a contractor and estate developer, said that since 1926 he had been concerned with the erection of about 18,000 houses, mainly around London. Of these, 12,000 were speculative, and 7,000 odd were contract houses for municipal authorities. Last year he had built about 5,000. Approximately 220 used gas only, and no electricity; 4,750 had electricity for lighting, gas in conjunction with electricity for heating, and gas only for cooking; 50 had electric lighting, heating, and cooking, and no gas.

Mr. *C. J. Whittaker* (President of the Brighton and Hove Chamber of Commerce) said that at a general meeting of the Chamber in December, 1933, he had moved a resolution emphatically disapproving of the policy of the Brighton Corporation in taking measures which prohibited the supply of gas to the extension of the Whitehawk Estate, on the ground that it was not in the public interest.

An amendment was moved by an Alderman of the Corporation, who had been Chairman of the Electricity Committee, that in view of litigation the Chamber reserved its opinion until the case for the Corporation had been published. The amendment, however, was overwhelmingly defeated, and the resolution was passed.

Mr. *Sydney Tatchell*, F.R.I.B.A. (a Past-Vice-President of the R.I.B.A.), F.R.San.I., dealing with a suggestion that the houses on the Corporation's estates were not designed for the safe and convenient use of gas, said there would be no difficulty whatever in introducing gas supplies into them.

Mr. *P. E. Browne* (General Manager of the Gas Company) also gave evidence in support of the Bill, and said his representatives had found a desire on the part of a number of tenants on the housing estates to use gas.

Cross-examined, Mr. Browne said he did not object to the Corporation wiring the houses for electricity for all purposes, so long as the tenants were given the option to use the medium they wished to use.

Asked whether he wanted to secure the right to supply the tenants of the Corporation's houses, without first obtaining the Corporation's consent, he said he believed he had that power under the Gas-Works (Clauses) Act, 1871, and the Brighton Company's Act of 1910. If he had not that power already, he wanted it.

Mr. FITZGERALD suggested that that was why the Bill was promoted.

Cross-examined by Mr. Macassey (for the Portslade U.D.C.), he agreed that in 1921 the Company had agreed to lay mains and service pipes for the supply to the Council's houses. He did not know that the Housing Commissioner had refused to allow the installation of both gas and electricity in those houses, on the score of expense.

Mr. MACASSEY said that one of the factors leading up to the agreement with the Council was that the tenants should be put under the obligation to pay for the hire of the piping and fittings supplied by the Company.

Mr. *Browne* replied that they were to pay for pipes and fittings only if they used gas.

Replying to a member of the Committee, Mr. Browne said that if the Bill passed, and if a tenant of a Brighton Corporation house required the electrical apparatus to be removed, the Corporation would no longer be entitled to charge for the apparatus.

Friday, March 9.

Mr. MAURICE FITZGERALD, addressing the Committee for the Brighton Corporation, said that the Bill was not promoted in the interests of the tenants. The Brighton Corporation tenants who wanted to occupy houses fitted with gas for cooking and heating had not the least difficulty in getting them if they chose to apply for them; the Corporation had constructed more than 2,000 houses which were piped with gas for cooking and heating; and there were over 900 which were termed all-electric, and which had a coal range in the living room. Quite a number of tenants preferred all-electric houses.

The only experimental canvass conducted by the Corporation before fitting-up houses was on the Rottingdean Estate; 30 houses were being erected, and 28 of the prospective tenants had asked that the houses should be all-electric.

The Bill was promoted by the Gas Company to increase its profits; he did not object to that, but what he did object to was that it wanted to increase its profits by imposing restrictions on the management by a particular class of owners of their properties, that particular class of owners being the housing authorities. It must mean increased expense to the Brighton Corporation.

The CHAIRMAN said that, as he understood it, the Bill did not give the Gas Company powers to do anything which it had not already power to do; it simply provided that there should not be a bias one way or the other.

Mr. FITZGERALD replied that that was no doubt the atmosphere the promoters wished to create, but he wanted to examine the Bill a little more closely.

The fact that the Brighton Corporation were electricity undertakers was entirely irrelevant to the issue. The undertaking had been particularly prosperous. It had never been a charge on the rates, but had contributed £173,000 to relief of rates. The revenue from the all-electric Corporation houses for the year to March, 1933, was about £5,700, whereas the total revenue of the undertaking was £368,000, so that it constituted 1½% only.

The policy of the Housing Committee was not adopted to bolster up the electricity undertaking, which needed no bolstering up, but was in the interests of economy and advantage to tenants; if the Bill passed, that policy would have to be reversed.

It was for the promoters of the Bill to justify the powers they sought, having regard to the particular facts of the case, and it was not for the Brighton Corporation to show how the circumstances differed from those dealt with in other Bills of this kind.

The rights between the owner and occupier of premises were settled by the agreement made between them. There was not a landlord in the country who would give to weekly tenants, who were not liable for repairs, a lease enabling them to have gas pipes or electricity wires put into the houses except with his consent and under his supervision. Did this Bill allow the Gas Company, by arrangement with the tenants, to pipe the houses for gas without the Corporation's consent, or without any right of supervision by the Corporation? If it did not, and if the Corporation's consent was still necessary, what on earth was the use of the Bill to the promoters, assuming that the Brighton Corporation was deliberately trying, in the interests of the electricity undertaking, to prevent the supply of gas to the houses?

The CHAIRMAN said it might not be as effective as the promoters would like it to be; but the Corporation could not insert a provision such as that in the tenancy agreements at present, that the tenants must pay 2s. a week electricity charges whether they paid for electricity or not.

Mr. FITZGERALD replied that that would not help the Gas Company if it could not install the pipes without the Corporation's consent, and if the Corporation chose to withhold consent.

The CHAIRMAN asked if this argument would apply to all previous Bills, which were in the same form as the present Bill.

Mr. FITZGERALD said he daresay it would. He suggested that the Bill would be useful to the Gas Company only if it got rid of the necessity for obtaining the Corporation's consent.

The CHAIRMAN asked whether, if there were no restrictive condition in the lease with regard to lighting, &c., a tenant could call upon the Gas Company for a supply of gas if his house were within 25 yards of a main.

Mr. FITZGERALD doubted that that was so in the case of a weekly tenant.

The CHAIRMAN said the clause in the Company's Bill was not an enabling clause. He wanted to know what was the effect of a tenancy agreement in which there was no restriction.

Mr. FITZGERALD said that, if there were no restriction in the agreement, he did not believe the tenant had any right to break up the floors or walls in order to install gas pipes.

The Brighton Corporation had no objection to a tenant having a supply of gas installed if he paid for it, but they objected to allowing capital expenditure to go to waste; if there were an electrical installation and the Corporation could not charge a tenant for it, then the cost would fall on the general body of ratepayers.

He asked the Committee to say that the Bill should not apply to the Brighton Corporation; or to insert a provision safeguarding the Corporation's rights, so that their property would not be entered upon and cut about without their permission, and safeguarding the right to charge in respect of the capital expenditure incurred in existing all-electric houses.

Alderman *H. M. Black*, J.P. (ex-Mayor of Brighton, and Chairman of the Housing Sub-Committee of the General Purposes Committee), said the Corporation had been pressed by the Government on previous occasions to keep down the cost of houses as much as possible, and the Corporation officials had pointed out that considerable saving would be effected if the houses were equipped only for electricity. Other factors were that, as the rooms in the houses were small, the atmosphere would not be vitiated if electricity were used, and that costs of re-decoration would be less.

Cross-examined, witness said he was not in favour of giving the tenants choice. He admitted that he used a gas cooker in his own house, but he did not change to electricity because he did not wish to scrap the gas cooker which he had bought. He did not know whether gas was cheaper than electricity.

Mr. TYLDESLEY JONES: Yet you impose electricity upon the tenants of the Corporation's houses.

Mr. *E. Taylor* (Manager of the Corporation Housing Estates) said that an exchange of houses by tenants who did not wish to live in all-electric houses could be arranged easily. The demand for all-electric houses was greater than for all-gas houses, so that if the occupier of an all-electric house wanted a gas house it would be easy to effect an exchange.

Mr. *D. Edwards*, M.Inst.C.E. (Borough Engineer and Surveyor), said that the total cost of installing gas for cooking and heating in an existing all-electric two-bedroom house would be £23 13s. 8d., made up of £12 16s. for bringing in the pipes and £10 17s. 8d. for structural alterations to enable gas heating to be used in the bedrooms.

Mr. *W. N. C. Clinch*, A.M.I.E.E. (Borough Electrical Engineer), gave figures to show the extra costs involved in equipping houses for gas as well as for electricity.

Mr. TYLDESLEY JONES, cross-examining, pointed out that under the Electricity Acts the owner of an estate could compel an electricity undertaking to provide mains for the supply to the tenants on that estate, if he gave a guarantee for three years for 20% of the cost of the mains. At the end of the three years there would be no obligation to use a single unit from those mains. By virtue of the Corporation owning the electricity undertaking and the housing estate, however, they were able to impose a tie on the tenants and secure that the mains should be used practically for all time, whereas if the estate were in the hands of a private owner they could not do that.

Mr. *A. G. Pollard* (a tenant on the Whitehawk Estate) said he had recently applied to the Corporation for a power circuit so that he could use electricity for all purposes. He had found it cheaper than when gas was used for cooking. In a recent canvass of tenants in all-electric houses he had visited about 20, and they were all keen that the houses should remain all-electric.

Mr. TYLDESLEY JONES, cross-examining, said he gathered that the people interviewed had thought the Bill would compel them to use gas.

Mr. *Pollard* agreed. [Laughter.]

Mr. EDGAR MACASSEY (addressing the Committee on behalf of the Portslade Urban District Council) submitted that the burden was on the promoters of the Bill to satisfy the Committee that there was a case for the inclusion of the Portslade area within the purview of the Bill. Portslade did not possess an electricity undertaking.

The CHAIRMAN said the Committee were prepared to hear arguments as to factors which rendered the principle inapplicable in this case.

Mr. TYLDESLEY JONES said the matter of the principle had been thrashed out in debate in the House and in Committee. It was not necessary in order to show that the principle should be applied to any area, to prove that that area had an electrical undertaking, or imposed restrictions.

The CHAIRMAN asked whether, if the Bill passed, there was any way in which the U.D.C. could come under any liability.

Mr. MACASSEY said he did not assert that there was, but he did not know what difficulties might arise.

The Committee consulted privately, and found the preamble of the Bill proved.

Lea Bridge Order

Inquiry under the Gas Regulation Act

The whole of Friday, March 2, was devoted to an inquiry by Mr. J. E. Ronca (Director of Gas Administration) at the Offices of the Board of Trade in London into a Draft Order under the Gas Regulation Act promoted by the Lea Bridge District Gas Company. The main purpose of the Order is to authorize the Company to use certain lands, now in its possession, for the purposes of gas manufacture, and there was opposition by the Lea Conservancy Catchment Board, the Leyton Borough Council, and the Warner Estates, Ltd., and Col. Warner. There was also an opposition with regard to a clause relating to the ranking of debenture stocks, but the clause was subsequently withdrawn. The promoters were represented by Mr. F. J. Wrottesley, K.C., and Mr. H. Royston Askew; the Lea Conservancy Catchment Board was represented by Mr. Jacques Abady; the Leyton Borough Council by Mr. J. Atkinson (Town Clerk), and the Warner Estates, Ltd., and Col. Warner by Mr. Maurice Fitzgerald.

Mr. WROTTESLEY, K.C., explaining the case for the Lea Bridge District Gas Company, said the principal object of the Order was to authorize the Gas Company to use for gas manufacturing purposes certain lands now in its possession and which at present it did not possess powers to manufacture gas upon. The Company, he said, began as a limited liability company as far back as 1868, and in 1878 it obtained statutory powers and was incorporated as a statutory company in the usual way. The area of supply was the Borough of Walthamstow and a considerable part—about one-third—of the Borough of Leyton. The site now occupied by the Company comprised some 13 acres, and at the present moment this was fully occupied by plant, stores, &c. The last addition to the lands owned by the Company was some 2½ acres in 1922, but that was comprised in the 13 acres already mentioned. As indicating the justification for the present proposal to use a larger proportion of the lands for gas manufacture, Counsel pointed out that, when the additional land was obtained in 1922, the output of gas was 801 million c.ft. and the consumers numbered 27,400. In 1933, the make of gas had increased to 1,100 million c.ft. and the number of consumers to 42,900. During the same period the maximum day's output had increased from 3 million to 4·3 million c.ft., and, added Counsel, he believed the Department would agree that a Company with statutory liabilities such as those possessed by gas undertakings must be allowed to expand and re-organize its works in order to anticipate the demands likely to be made upon it by the public. A large increase in the industrial demand was anticipated having regard to the fact that at the present time there were industrial consumers who took as much as 20 million c.ft. per annum each. There had also been an extraordinary growth in the gas fire business in private houses, and that in itself necessitated having a bigger margin of manufacturing plant. Gas cooking and heating involved extraordinary fluctuations in the demand, and the extent of this was to be seen in the figures for the number of heaters and cookers over the past 12 years. In 1922 there were connected 21,480 cookers and 1,775 fires, but on Jan. 1, 1934, the figures were 38,600 cookers and 7,900 fires, the percentage increases being 9·8% and 347% respectively. Having regard to all these circumstances, Mr. Wrottesley said there would be real danger if the Company did not look ahead now and provide for further manufacturing capacity in the future.

Remarking that the land upon which permission was asked to manufacture gas was already owned by the Company, Counsel pointed out that there are three plots, the first and largest being some 2 acres adjoining the land now used for gas manufacture, and opposite some land outside now being developed for housing purposes. Thus any works put on this 2 acres of land would be on the other side of the road on which the houses were being built. Incidentally, it was mentioned that next to the houses now being built was also a dump where refuse had hitherto been shot, but it was understood that this was being removed and would be built upon.

Objections to the use of this land had been put in by the Leyton Borough Council and by Warner Estates, Ltd., and Col. Warner. The petition against the Order by the Leyton Borough Council stated that if the Company's proposals were granted, they would seriously reduce the letting and selling value of the houses in the vicinity and the rateable value would decrease. On this point, Mr. Wrottesley said there was really nothing in that argument because houses had been continuously built in the neighbourhood of the gas-works, which were on the same site as far back as 1868. Indeed, houses had been built in such a way that the gas-works had been practically ringed in with houses. An examination of the rate-books suggested that the property nearest the gas-works was of a higher rateable value than the houses farther away. In any case, there was no evidence that a house close to the gas-works did not fetch the same rent as one farther off.

A second objection was that the existence of gas manufacturing plant on this land would be detrimental to the occupiers of the houses. However that might be, the fact was that all the houses in the neighbourhood were in great demand and the Gas Company had the greatest difficulty in securing any of them for their own employees from time to time. On the other hand, continued Mr. Wrottesley, it was not unimportant from the point of view of the inhabitants of the area that the Gas Company should be able to meet all the needs for light, heat, cooking, and power. Incidentally, the Leyton Borough Council owned its own electricity undertaking and would fully appreciate that to prevent the re-organization of any public utility undertaking of this character must tend to make the cost of the commodity to the public dearer.

Dealing with the objection of the Warner Estates, Ltd., and Col. Warner to the use of the land—the Company being concerned with some hundreds of houses and Col. Warner with a few close to the gas-works—Mr. Wrottesley said he understood the Warner Estates, Ltd., had leases of 1,000 years, so that for practical purposes they were the freeholders.

The reasons for the opposition were much the same as those put forward by the Leyton Borough Council, objection being taken to the erection of gasholders, retorts, and noisy machinery, and also to the conversion and working-up of residual products on these lands owing to the close proximity to the houses on the Estate. It was suggested that the value of the property would be reduced and that it would become difficult to let it. Therefore, the objection practically asked that Clause

4 of the Draft Order relating to the use of these lands for gas-making purposes should be struck out.

Another objector to the site was the Lea Conservancy Catchment Board, which authority had just come into existence as successors to the Commissioners of Sewers, and their objection was in regard to a watercourse or sewer known as Shortlands Sewer, an open culvert running alongside the Company's land and connecting with the Dagenham Ditch. The object of the objection of the Catchment Board was to obtain a protective clause of a nature which the promoters were not disposed to agree to. At the present time the representatives of the Catchment Board made use of the Company's land on the site for the purpose of clearing the watercourse from time to time by arrangement with the Company, but under the proposed clause the Catchment Board would be given statutory rights which in his opinion, said Mr. Wrottesley, there were doubts if they possessed them at the present time. He added that he doubted whether the Board really knew what its own rights were in this matter and therefore the Company was prepared to insert a clause in the following terms:

> Nothing in this Order contained shall take away, control, suspend, prejudice, or interfere with any of the rights, privileges, jurisdictions, powers, or authorities vested in or belonging to the Lea Conservancy Catchment Board, and all such rights, privileges, jurisdictions, powers, and authorities shall be valid and effectual as if this Order had not been made.

That, said Mr. Wrottesley, would not take away the rights which the Catchment Board at present possessed, but in view of doubts as to what its rights really were he was not prepared to accept a clause giving the Board specific rights in regard to the site. On the other hand there was no intention whatever of curtailing in any way powers the Board now possessed. In the clause proposed by the Board, however, it was laid down that the Company must not come within 10 ft. of the Ditch, although the land was the property of the Company now, and that the right of access should be accorded the Board's representatives.

The DIRECTOR, referring to the position of the Catchment Board, asked if there was any opposition as to pollution of the sewer.

Mr. WROTTESLEY said there was no need for that to be raised on this Order because the Board had the ordinary powers at common law in regard to that.

Mr. ABADY said the Catchment Board had in mind the question of obstruction to the flow of the Ditch, but it did not ask for any special protection as to pollution, and the question of obstruction was dealt with in the clause which he proposed to submit to the Director.

Mr. *D. C. Cross*, Engineer and Manager of the Lea Bridge District Gas Company, confirmed the general particulars of the undertaking given by Mr. Wrottesley, and said that, having regard to the present output of the Company, the area of land now available for gas making purposes was slightly under the average of the whole of the gas-works throughout the country, and, as things stood at present, there was no provision for future development. Speaking of the development of the undertaking as between 1922 and 1933—according to the figures already given—Mr. Cross said this had taken place side by side with the keenest competition from electricity. The price of electricity in his area was as low as anywhere in and around London, beng down to ½d. per unit as the secondary charge. The present storage capacity was only 77% of the maximum day's output. In view of the present fluctuating loads he regarded the position as becoming dangerous, because no undertaking could feel really safe unless it had sufficient storage for the full maximum day's output.

Supporting what had been said as to the rateable value of the houses nearest to the gas-works, Mr. Cross said the houses abutting on to the works had a rateable value of £11 and further away from the works the figure varied from £10 to £11, although the houses were of the same size and type. It was obvious the proximity of the gas-works made no difference to the value of the property, which was in great demand.

Mr. MAURICE FITZGERALD cross-examined at some length on behalf of the Warner Estates and Col. Warner, and put many questions regarding the detrimental effect of a gas-works upon the surrounding property.

Mr. *Cross* maintained his view that the gas-works did not depreciate the value of such property, and, on the question of health, pointed out that the local Medical Officer of Health had said that the neighbourhood of the gas-works was the healthiest spot in the district.

In the course of further questions, Mr. Fitzgerald called attention to three agreements between the Gas Company and Warner Estates, Ltd., under which land was purchased by the Gas Company with certain restrictions as to its use, erection of retorts being prohibited, and he suggested the Company should at least come under similar restrictions in regard to the lands now being discussed.

Mr. *Cross* said in that event the Company would still be hampered as regards the re-organizing and development of its gas-making plant.

Mr. FITZGERALD suggested the possibility of the Company purchasing certain land from the Leyton District Council, on the other side of the Ditch—previously mentioned—but now used as a recreation ground. If that were done, the works would not be built so close to the existing property as would be the case under the Company's proposal, and, moreover, he contended this was a natural way of developing the works.

Mr. *Cross* pointed out the difficulties in this scheme.

Mr. FITZGERALD then commented on the fact that if the proposed lands were used for gas manufacturing purposes, the employees' recreation ground would have to be used and accommodation found elsewhere.

Mr. *Cross* agreed, and said some steps in that direction would have to be taken. He added that he knew of no other land in the district which could be acquired for gas-works purposes.

Mr. FITZGERALD, in the course of further questions said his clients were apprehensive that when the present admitted shortage of houses was caught up by the rapid building operations of local authorities and private enterprise, the value of this property must depreciate, because people would have a better choice of where to live and naturally would not choose a spot close to a gas-works.

Mr. *Cross*, answering other questions, said the greatest need for extension at the moment was storage. At the same time, the manufacturing plant—all of which was on the west side of the land—was extremely congested, and it was necessary to reorganize and re-plan the works with the view to meeting future demands. At the moment, however, it was impossible to say precisely how the work would be done.

Mr. JACQUES ABADY then cross-examined with regard to the opposition of the Catchment Board and pointed out that the employees of the Board—or the previous Commissioners—had been allowed access to the Company's land on the site for the purpose of repairing and cleaning the Ditch and as the Company had never raised any objection—indeed, the Company had given its permission—he suggested it was not unreasonable to ask for this to be put into a clause. Moreover, in asking that the Company should not come within 10 ft. of the bank of the Ditch, Mr. Abady said he was only asking for the present condition of things to be maintained.

Mr. *Cross* said that was not the fact. Actually, the Company had been gradually raising the level of the site, and in parts had come within 6 ft. of the bank of the Ditch. It was true that a representative of the Board had warned the Company that it had no right to do this, but he was told he must prove the Board's authority to give such a warning. Continuing, Mr. Cross said the intention was to put a concrete wall down the face of the bank of the Ditch on the Company's side, and he was prepared to build within a few feet of that wall. He added that such a wall would improve the flow of the Ditch and that the Company would give the Catchment Board the same facilities it always had given.

Mr. JOHN ATKINSON (Town Clerk, Leyton Borough Council) also put questions as to the depreciation of property in the vicinity of the gas-works and the danger of the Council losing rates thereby.

Mr. *Cross's* answers were similar to those previously given on this point.

Mr. ATKINSON further put the point that the Company had not shown any urgent need for adding to its gas-making plant, emphasizing that in 1933 there had actually been a slight decrease in the quantity of gas sold as compared with 1932.

Mr. *Cross* replied that that was due partly to a change in the date of meter reading and also to the extraordinarily fine weather in 1933.

Mr. MAURICE FITZGERALD then addressed the Director, contending that the use of these lands for gas-making purposes would seriously affect the value of the surrounding property which so far had been protected by the agreements entered into between the Company and Warner Estates, Ltd., to which reference had been made. With regard to the land on Leyton Marshes, he urged the desirability of using this, and said that under the Leyton Urban District Council Act of 1904 the Council could sell portions of that land.

The DIRECTOR in this connection intimated that he would probably have to visit the site.

Mr. FITZGERALD, in his concluding remarks, said that if the Director could not see his way to refuse the use of the proposed lands altogether for gas making purposes, he asked that the same restrictions should be imposed as were embodied in the agreements between the Gas Company and the Warner Estates, Ltd. At the same time, he added, he would not be satisfied with that to the extent of withdrawing opposition when the Order came before the House, and he reserved that right to his clients.

Mr. JOHN ATKINSON, speaking for the Leyton Borough Council in connection with the suggested use of part of Leyton Marshes, said he had no doubt his Council would consider such a proposition.

Mr. WROTTESLEY, for the promoters, impressed upon the Director that Mr. Atkinson had no authority from his Council in that respect, and that there was no evidence before the Director as to what attitude the Council would take.

Mr. ATKINSON said that if the Director would adjourn the inquiry for a short while he would undertake to get the views of his Council on this point.

Mr. WROTTESLEY briefly replied on the cases put forward by Mr. Fitzgerald and Mr. Atkinson. Speaking with regard to the Lea Conservancy Catchment Board, he remarked that he had been discussing the position with Mr. Abady, and they had agreed to ask the Director to close the inquiry subject to the engineers on either side meeting and endeavouring to deal with the matter in an amicable manner. The parties would keep the Director informed as to the progress that was being made, and it might not be necessary for the inquiry to be resumed. If it was found impossible to come to an agreement, then the point would have to be argued before the Director.

The DIRECTOR acquiesced in this course, remarking that, apart from the position as between the Company and the Catchment Board, the inquiry would be regarded as closed.

Gas Companies' Results in 1933

Barnard Castle.

Barnard Castle Gas Company show a profit on the year of £998 9s. 8d., and dividends of 2½% on the original consolidated stock and £1 15s. 7d.% on the new ordinary stock, less tax, were approved.

Cleveland.

The profit made by the Cleveland Gas Company during the half-year to Dec. 31, 1933, has been £603, to which must be added the amount brought forward from last half-year, £4,431, making the balance at the credit of the profit and loss account at Dec. 31, 1933, £5,035. This sum the Directors proposed should be disposed of as follows: In paying a dividend at the rate of 2% per annum (less income-tax) for the half-year, and reserving for repairs to the Skelton gasholder £200, leaving to be carried forward to next half-year's account the sum of £4,436.

Dartmouth.

The profit on the year's working of the Dartmouth Gas, Coke, and Coal Company (after charging to revenue all renewals, repairs and maintenance, and depreciation on meters and gasholders) is £2,432. After charging £280 interest on mortgage debentures and £84 interest on the first preference shares, and £146 for income-tax, there remains a balance available for distribution of £2,625. The Directors recommend the full dividend of 6% on the second preference shares, less income-tax, absorbing £180, and a dividend of 11% on the ordinary shares, less income-tax, absorbing £1,254, and purpose carrying the sum of £500 to the general reserve fund account, leaving a balance to be carried to the next account of £691.

Dublin.

The accounts of the Alliance and Dublin Consumers' Gas Company for the half-year ended Dec. 31 last show a profit on the revenue account of £68,445, and, after providing for interest on debenture stock, interest on temporary loans, and income-tax, there remains the sum of £53,764, to which must be added the sum of £29,185, being the balance brought from the last account, making a total of £82,950. The Directors recommended a dividend at the rate of £7% per annum, less income-tax, on the consolidated ordinary stock of the Company. This absorbs the sum of £54,315, after which a balance of £28,635 is carried to the next account.

East Grinstead.

In submitting the annual statement of accounts the Directors of the East Grinstead Gas and Water Company report that the receipts from gas and meter and stove rentals in 1933 amounted to £20,652; from residual products £5,538; and from water and meter rental £10,625. After payment of the interim dividend, interest on debenture and other fixed charges, the profit and loss account shows a balance of £11,228 available for dividends, from which the Directors recommended payment for the half-year ended Dec. 31, 1933, of £3% on the preference shares, £5% on the original "A" stock and "A" shares, £3 10s.% on the "B" and "C" shares (less income-tax), which, with the interim dividend paid on the preference shares, "A" stock and "A" shares, and "B" and "C" shares, will make £6, £10, and £7% respectively for the year. This will absorb £3,101, and leave a balance to be carried forward of £8,126. Very satisfactory progress has been made during the year. Gas sales continue to increase and the revenue received from water creates a record. There is a further increase in the gas sold amounting to approximately 2%, which brings the total gas sales to 447,968 therms during the year.

Gosport.

The Gosport District Gas Company again report a progressive increase in the sales of gas for the past year, amounting to 16 million c.ft., well distributed over the six districts of the Company's area of supply. Within the past three years the Company's production of gas has increased by more than 80 million c.ft., the actual output for 1933 being 480 million c.ft. More than 1,100 new consumers have been connected during 1933, the largest number added in any one year. The gross profit for the year, £17,421, was also the largest in the history of the Company, and the turnover on the revenue account, which had increased by £2,200 to £95,798, was the highest yet obtained. The increased demand for gas and the lower cost of production has enabled the Directors to make considerable reductions in price. The continued demand for appliances of all kinds emphasized the growing importance of this department of the Company's business, the turnover for the year being over £14,000. The total number of consumers is now 13,739. In addition to the public lighting contract with the Gosport Corporation, the Company have been successful in obtaining five-year contracts for the lighting of Bishop's Waltham and Wickham in competition with the two large neighbouring electricity supply undertakings. New capital had been issued during the year comprising £5,000 4% perpetual debenture stock and £10,000 5% perpetual preference stock, which has been obtained at average prices of £100 6s. and £106 10s.% respectively. Some £17,000 had been spent on new plant and mains. The result of the year's working was that after contributing £1,804 to the renewals fund, the balance to be carried forward to the profit and loss account was £17,421. It was decided to pay the maximum dividends of 5% on the preference stock and £7 16s.% on the consolidated ordinary stock.

Hexham.

The annual report of the Hexham Gas Company shows a gross profit for 1933 of £3,071, and the Directors recommend a dividend of £3 10s.%, less tax, on the ordinary stock, making, with the interim dividend paid in September last, £6% for the year.

Horley.

The Directors of the Horley District Gas Company submit a report for the year ended Dec. 31, 1933, stating that after payment of dividends in respect of the half-year ended June 30, 1933, at the standard rates, all less income-tax, and providing for the fixed charges for interest, &c., the profit and loss account shows an available balance of £5,019. The Directors recommended payment of dividends in respect of the half-year ended Dec. 31, 1933, at the rate of 5% per annum on the preference stock; 10% per annum on the "A" capital stock, and 7% per annum on the additional "B" capital stock (all less income-tax), which absorbs the sum of £2,187, leaving a balance of £2,832 to be carried forward to the next account. Sales of gas have increased by over 1¾ million c.ft., and the sales of appliances also show a substantial increase. A total of 232 new consumers have been added.

Launceston.

The profits of the Launceston Gas Company, after providing for depreciation and income-tax, amount to £1,333. From this sum must be deducted bank interest, mortgage interest, provision for income-tax, and preliminary expenses written off, amounting in all to £479. This, together with the balance of profit and loss account, brought forward from the previous year after the payment of dividends, makes a total of £1,076, which the Directors recommend should be applied in the payment of a dividend at the rate of 6% on the ordinary shares, and 5% on the additional shares for the year, and in carrying £250 to retort renewal reserve, leaving a balance to be carried forward of £250. The sale of gas shows a small decrease against the previous year. The Company's mains have been further extended during the year, and there has been an increase in consumers of 44.

Ilfracombe.

The accounts of the Ilfracombe Gas Company show an available balance of £3,708 after paying an interim half-yearly dividend of £2 10s.% on the preference stock and £3 5s.% on the consolidated ordinary stock. The Directors recommended a further payment of £2 10s.% on the preference stock and £3 5s.% on the consolidated ordinary stock. The net balance from revenue carried to the profit and loss account is more than sufficient to cover the full capital charges for 1933. The balance-sheet reveals the strength of the Company's financial position, for the revenue profit of £4,671 brought in to the profit and loss account from the year under review, the £3,018 which stands at the credit of the reserve fund, and £3,917, the sum at the special purposes fund, amount together to the sum of £11,607. The gross receipts for the year amount to £28,874, against £29,956—a reduction of £1,081; but the lowering of the price of gas by ½d. per therm, made last year, accounts for £1,164. The total output of gas was less by 1,053 therms, or 0·21%. Receipts from public lighting and rental of meters are up. Over 300 new gas appliances were sold during the year under review.

Looe.

The report of the Looe Gas and Coke Consumers' Company states that the sales of gas appliances still continue to show a satisfactory increase. The balance carried to profit and loss account is £2,265. A dividend of 8% on the ordinary shares and 6% on the cumulative preference shares was recommended by the Directors.

Maryborough (Queensland).

The Directors of the Maryborough Gas and Coke Company, Ltd., Queensland, present their half-yearly report and balance-sheet, which shows that for the first four months of the period sales of gas showed a decrease as compared with the corresponding four months of 1932, but the sales for November and December show a slight increase as compared with the same two months of 1932. The money value for these two months is, however, slightly less, owing to the reduction in price charged in 1933. The increased consumption referred to above is the first recorded since 1929. Residual products show an increase,

due to more tar sales. Expenditure is slightly less than the December period of 1932. After writing off £500 for depreciation, and making provision for all other charges, the profits amount to £1,227, out of which the Directors recommend payment of a dividend of 5% per annum, leaving a balance to be carried forward of £196.

Minehead.

The balance of net profit on the Minehead Gas Light and Coke Company for the year is £4,397, which, added to the amount brought forward from the last account, £1,369, makes a total of £5,767. After deducting income-tax, £1,013, and mortgage interest, £444, carrying £250 to leasehold depreciation fund account, there remains a balance available for distribution of £4,060. The Directors recommend the declaration of a dividend of 8%, less income-tax, on both the £5 and £1 shares, which absorbs £2,820, leaving a balance to carry forward of £1,240. The Directors deeply regret to report the decease of Mr. John Burgess, J.P., Chairman, who served as a Director since 1914, and was Chairman of the Company from 1924 until August, 1932. Mr. S. J. Burgess was appointed a Director of the Company to fill the vacant post. The sale of gas was 57,637,700 c.ft., a decrease of 2,214,600 c.ft., or 3·7% below 1932. The net gain in consumers for 1933 was 41, while the gains in apparatus were 57 cookers, 31 water heaters, 22 wash-boilers, 64 gas fires, and 18 radiators. During the year larger exhasters have been installed, and one bed of retorts re-set.

Narborough.

The working results of the Narborough, Blaby, Enderby, and Whetstone Gas Light and Coke Company in the manufacture and distribution of gas are again satisfactory. The net increase in the number of consumers is 330, and a large number of additional appliances have been placed on the district. The consumption of gas has further increased by 5½%. The Directors have placed an order for increasing the storage capacity of No. 4 holder by adding a third lift, and a coke cutting and grading plant is proposed to be erected to meet the demand for graded coke nuts. At the end of June last the issue of £5,000 debentures made in 1923 matured, and a new issue was allotted totalling £8,000 at the lower rate of 4½%. It was recommended that a final dividend be paid on the ordinary capital of the Company of 2s. 6d. per share, making, with the interim dividend paid at August last, 10% per annum, together with a bonus of 2s. 6d. per share, both less tax, transfer £1,000 to the renewals fund, and carry forward to the next accounts the sum of £9,143.

Northwich.

The sales of gas by the Northwich Gas Company for the year were very satisfactory, 99,575,000 c.ft. (497,878 therms) being sold, as against 94,615,000 c.ft. (473,077 therms) for the previous year, an increase of 4,960,000 c.ft. (24,801 therms). The revenue account shows a profit of £7,086, and after payment of interim dividends, interest on loans and reserve fund, there is, with the addition of the balance brought forward, a disposable balance of £7,036. The Directors recommended that a dividend be paid at the rate of 4% per annum on the preference shares (free of income-tax), 5% per annum on the preference stock (less income-tax), and 7% per annum on the ordinary stock (less income-tax) for the past half-year, which absorbs £2,373, making with interim dividends 4%, 5%, and 6% respectively for the whole year, transfer £250 to waterless holder suspense account, and £500 to contingency fund, leaving a balance of £3,913 to be carried forward. The Directors have also decided that a reduction in the price of gas will be made after April 1, 1934. At an Extraordinary Meeting held immediately after the General Meeting the Directors asked the proprietors to pass resolutions authorizing them to raise new capital to meet the cost of extensions in works, mains, &c.

Rochester (S.E. Gas Corporation).

The capital account of the Rochester, Chatham, and Gillingham Gas Company, which has a balance of £21,266, shows that during the year there was an expenditure of £1,450 only, and that this was more than counterbalanced by a credit of £2,350 in respect of depreciation of meters and sale of land. The cost of manufacture is reduced from approximately £128,000 in 1932 to £108,900 this year. The reduction is largely accounted for by a decrease of £11,625 in the sum spent on the repairs and maintenance of works and plant. The sales of gas are practically the same as in 1932. Public lighting and under contract shows an increase in revenue of £430—a very clear answer to the claims of the electrical propagandists who have declared that gas lighting has already received its death blow. During the year the Company's mains have been extended to provide a supply of gas to Walderslade and further extensions are under consideration. The balance carried to the net revenue account is £37,964. After paying dividends for the first half-year and after contributing £1,905 to the renewal fund and paying the second half-year's dividend on the irredeemable preference stock there is an available balance in the account of £41,646. Out of this the Directors recommended the payment of a dividend for the second half-year on the consolidated ordinary stock at the rate of £6 10s.% per annum, less income-tax. This absorbs

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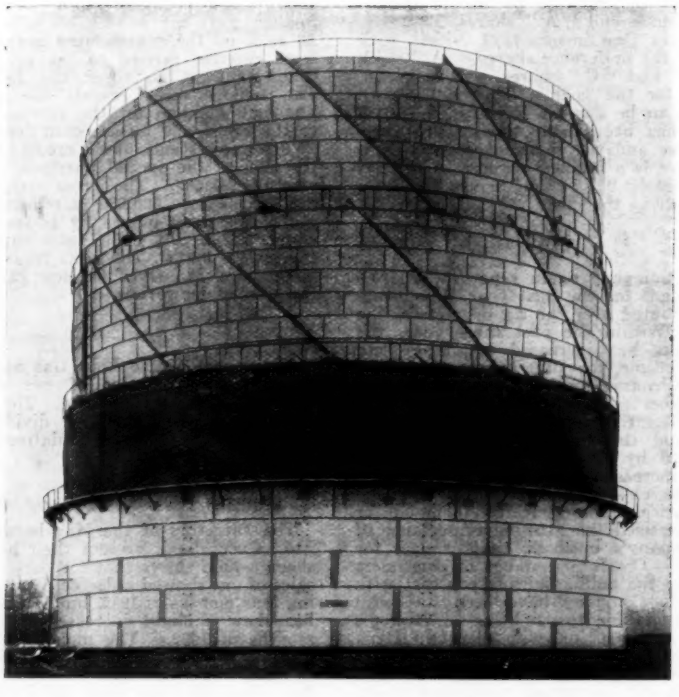

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413

the sum of £10,759, leaving £30,887 to be carried forward to the credit of the current year.

Rushden.

The business of the Rushden and Higham Ferrers Gas Company during the year is reported to have been satisfactory. The balance brought forward on the profit and loss account at the beginning of the year was £20,392, compared with £21,933 at the end of 1933. A total profit on the year of £7,707 was revealed, which, with the balance brought forward, £258 from 3½% War Loan, and £136 from 4% Consols, made a total of £28,495. Income-tax amounted to £2,323, and interest on mortgages, debentures, &c., reduced the amount available for dividends to £25,235. The Directors proposed the same dividend as in the half-year ended June 30 (£15 10s.% on original stock, and £10 17s.% on additional stock), and, as a result, the sum of £21,933 will be carried to the 1934 account.

Seaham Harbour.

The Seaham Harbour Gas Company completed the year with a credit balance on the revenue account of £2,874, being £223 more than the previous year, which in the circumstances was highly satisfactory. The total for allocation, including £1,111 brought forward, was £3,985. After meeting charges there was a balance of £2,072 to be carried forward subject to final dividends for the half-year ended Dec. 31. Dividends of 4½% for the year on the preference stock, 6% on the "A" and "B" stock, and 4½% on the "C" stock were declared.

Whitby.

The profit and loss account of the Whitby Gas Company, after charging interest on debenture stock, preference stock, banking account, deposits, and mortgages, and after providing for the interim dividend, shows a balance of £1,889, out of which the Directors recommend the payment of dividends at the rate of 3½%, less income-tax, on the original capital, and of £2 9s.%, less income-tax, on the additional and new additional capital, for the half-year ended Dec. 31, 1933, making with the interim dividends 6½% on the original capital and £4 11s.% on the additional and the new additional capital for the year. This will absorb £1,071, leaving a balance of £818 to carry forward. During the year 117 new consumers have been connected up, and the output of gas shows an increase on the previous year. New mains have been laid and old mains re-laid in various parts of the town to meet the increased demand for gas.

Edward Cockey & Sons, Ltd.

The Annual General Meeting of Messrs. Edward Cockey & Sons, Ltd., was held at the offices of the Company, Garston Works, Frome, Somerset, on March 7, Mr. C. HOLMES HUNT, M.A., presiding, supported by Mr. J. Button, J.P., Mr. R. L. Button, and Mr. W. A. Perkins, and other shareholders.

The CHAIRMAN, in moving the adoption of the Report and Accounts, called attention to the changes in the personnel of the Board during the last year. The late Chairman, Mr. J. J. Baines, and Mr. W. R. D. Perkins resigned their Directorships on the disposal of their interest in the Company, and the Board recorded their appreciation of the services rendered by these gentlemen to the Company. Their interests had been acquired by the present Directors and their friends, and as a result his colleagues had done him the honour to elect him Chairman of the Board.

In the place of Mr. Baines and Mr. Perkins, Mr. W. A. Perkins (who had for many years been acting as Secretary of the Company and would continue so to act) and Mr. R. L. Button had been elected.

On account of the continued depressed state of trade generally, continued the Chairman, inquiries had not been numerous and orders had been very hard to obtain and then only at highly competitive prices. However, such economies as the Directors had been able to effect during the past year had enabled the Company to show a small profit on its working, after making due allowance for depreciation, of £503. To this figure had to be added the amount brought forward—viz., £1,714—making a total balance available of £2,217, out of which the Directors recommended a dividend at the rate of 2½%, less tax, which would absorb £500, leaving the sum of £1,717 to be carried forward. Although the dividend would absorb most of the profit, yet they had a substantial carry forward.

Notwithstanding the adverse conditions prevailing, their general financial position was not unsatisfactory, the balance-sheet showing that, while their trade creditors amounted to roughly £1,300, on the other side sundry debtors were £2,600, and stock and work in progress amounted to nearly £4,000, while cash at bankers was nearly £6,000.

The general reserve remained the same at £5,000, as also did reserve for bad debts, £300. The benevolent and pensions fund stood at £1,533.

Concluding his speech, the Chairman said there were signs of some improvement in trade, though much leeway had yet to be made up before their particular branch of business could benefit.

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GAS MARKETS & MANUFACTURES

Stock Market Report.

[For Stock and Share List, see later page.]

The recent activity on the Stock Exchange eased up last week, and with the exception of the gilt-edged market most sections became depressed with consequent falls in value. It is not anticipated, however, that this set-back will continue for any length of time, as the lower prices will eventually tempt buyers and markets should then revert to brighter conditions.

Business in the Gas Market was also on a reduced scale, but despite this several stocks improved in value. Inquiries for Cardiff consolidated led to a sharp rise of 4 points to 127½; Alliance and Dublin registered a further increase of 2½ to 135, which price still includes the full final dividend of 3½%; and both Bournemouth sliding-scale and South Suburban 5% preference hardened 2. It will be seen in the Stock and Share List that there were several other minor increases and no prices were marked down.

At the time of writing the supplies of debenture and preference stocks are very limited, and, with the exception of a parcel of £30,000 Hornsey 4% perpetual debenture which is offered at 105 (free of stamp duty) yielding £3 16s.%, there are only a few small lots on the market. There is more choice among ordinaries, however, and the list of stocks available includes the following:

Amount Offered.	—	Dividend.	Price.	Yield.
£		%		£ s. d.
600	Bedford	5½	111	4 14 6
880	Bristol	5	116	4 6 2
820	Commercial	5½	123	4 13 6
1,090	Eastbourne "B"	6½	134	4 17 0
5,000	European	6*a*	135	5 18 6
5,000	Gas Light units	£5 12s.	26s. 3d	4 5 4
10,000	Imperial Continental	12	208½	5 15 0
345	Portsmouth	8	172	4 13 0
10,000	South Eastern Gas Corpn.	6	28s. 6d.	4 4 2
10,000	South Metropolitan	6	134	4 9 0
380	South Shields	8½	173	5 0 0
5,000	South Western Gas Corpn.	..	21s. 6d.*b*	..
1,500	Swansea	5	111	4 10 0
498	Watford	6¾	152	4 9 0

a Free of tax. *b* Free of stamp duty.

The accounts of the British Gas Light Company show that, despite a small decrease in the sales of gas, the net profit for the past year amounted to £84,503, against £78,187 for 1932. General reserve has been increased by £10,000 to £160,000, and the Directors are recommending a final dividend on the ordinary stock of 4%, making 7½% for the year (unchanged). The balance forward is slightly higher at £88,019.

Current Sales of Gas Products.

The London Market for Tar Products.

LONDON, *March* 19.

The Tar Products market continues steady with but little change in prices, which are about as follows:

Pitch, 57s. 6d. per ton f.o.b.

Creosote, 3d. to 3¼d. per gallon.

Refined tar, 4d. to 4¼d. per gallon in bulk at makers' works.

Pure toluole, about 2s. 8d.; pure benzole, 1s. 10d. to 1s. 11d.; 95/160 solvent naphtha, about 1s. 9d.; and 90/140 pyridine bases, about 6s.—all per gallon naked at makers' works.

Tar Products in the Provinces.

March 19.

The average prices of gas-works products during the week were: Gas-works tar, 23s. to 28s. Pitch—East Coast, 56s. 3d. to 58s. 9d. f.o.b. West Coast—Manchester, Liverpool, Clyde, 56s. 3d. to 58s. 9d.* Toluole, naked, North, 2s. 2d. to 2s. 4d. Coal-tar crude naphtha, in bulk, North, 6½d. to 6¾d. Solvent naphtha, naked, North, 1s. 5d. to 1s. 6d. Heavy naphtha, North. 10½d. to 11d. Creosote, *ex* works, in bulk, North, liquid and salty, 2⅝d. to 2⅞d.; low gravity, 2½d. to 2⅝d.; Scotland, 2½d. to 2¾d. Heavy oils, in bulk, North, 3⅜d. to 4½d. Carbolic acid, 60's, 2s. 2d. to 2s. 3d. Naphthalene, £10 to £11. Salts, 55s. to 75s., bags included. Anthracene, "A" quality, 2½d. to 3d. per minimum 40%, purely nominal; "B" quality, unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *March* 17.

Refined tar has been sold at keen prices, but other products remain steady although new business is not too plentiful.

Crude gas-works tar.—The actual value is 35s. to 37s. per ton *ex* works.

Pitch.—There is little inquiry, and price remains nominal at 50s. per ton f.o.b. Glasgow for export, and round 47s. 6d. per ton *ex* works in bulk.

Refined tar is available in large quantities, but actual quotations remain at 3½d. per gallon *ex* works in buyers' packages.

Creosote oil.—Best grades are scarce in this area, and prices remain firm. B.E.S.A. specification is 4d. to 4¼d. per gallon; low gravity, 4d. to 4½d. per gallon; and neutral oil, 4d. to 4½d. per gallon—all in bulk *ex* works.

Cresylic acid.—Distillers are well sold on contract, and available supplies for prompt are small. Pale, 97/99%, is 1s. 1d. to 1s. 2d. per gallon; dark, 97/99%, 11d. to 1s. per gallon; and pale, 99/100%, 1s. 4d. to 1s. 5d. per gallon—all f.o.r. in buyers' packages.

Crude naphtha is unchanged at 4¾d. to 5¼d. per gallon, according to quality and quantity.

Solvent naphtha.—90/160 grade is 1s. 5d. to 1s. 5½d. per gallon, while 90/190 grade is 9d. to 10d. per gallon.

Motor benzole.—Supplies being scarce price is maintained at 1s. 7d. per gallon *ex* works in bulk.

Pyridines.—90/160 grade is 4s. 6d. to 4s. 9d. per gallon, and 90/140 grade is 5s. to 5s. 3d. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s. d.		s. d.	
Crude benzole	0 10	to	0 10¼	per gallon at works
Motor ,,	1 5	,,	1 5½	,, ,, ,,
90% ,,	1 5½	,,	1 6	,, ,, ,,
Pure ,,	1 8½	,,	1 9	,, ,, ,,

Contracts Advertised To-Day.

Coal.
Gainsborough Gas Department. [p. 772.]
Llandudno Urban District Council. [p. 772.]

Gasholder and Foundations.
Middleton Gas Department. [p. 772.]

Mantles.
Port Talbot Gas Department. [p. 772.]

Meters.
Port Talbot Gas Department. [p. 772.]

Pendants, Brackets, and Fittings.
Port Talbot Gas Department. [p. 772.]

Pipes.
Port Talbot Gas Department. [p. 772.]

Stores.
Port Talbot Gas Department. [p. 772.]

New Capital Issues.

Peterborough Gas Company.—The tenders for the £15,000 consolidated ordinary stock, which were offered on behalf of the Directors of this Company, were opened on March 13. They amounted to a total of £54,980 at prices ranging from £170 down to the minimum of £150 per £100. The lowest accepted tender was at £154 0s. 6d. per £100, and the average price obtained £157 9s. 8d.%.

Trade Notes.

Order for Centrifugal Washers.

The Mid-Kent Gas Light and Coke Company, Snodland, recently placed an order with Messrs. Kirkham, Hulett, & Chandler, Ltd., for two of their patent spiral centrifugal washers. One of these machines is to be used for the extraction of ammonia, and the other for the extraction of naphthalene from the gas.

Self-Adjusting Pipe Joint.

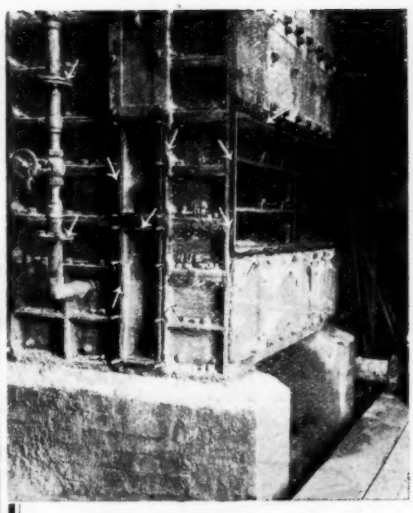
The many visitors who saw the new working model of the Stanton-Wilson self-adjusting pipe joint at the British Industries Fair, Castle Bromwich, will be interested to learn that during the Fair the vibrating joint made no fewer than 3,696,000 movements. The joint was used to couple two Stanton-Delavaud spun iron pipes, which were continuously vibrated in order to demonstrate the effects of traffic vibration on gas and water mains. We are informed by the Stanton Ironworks Company, Ltd., near Nottingham, on whose stand the joint was displayed, that the joint maintained the initial air pressure throughout the test, and did not once have to be tightened, re-made, or pumped up.

STOCK AND SHARE LIST.

Official Quotations on the London and Provincial Stock Exchanges.

Issue. £	Share.	When ex-Dividend.	Dividends. Prev. Hf. Yr. % p.a.	Dividends. Last Hf. Yr. % p.a.	NAME.	Quotations. Mar 17. (Provincial Exchanges Mar. 16.)	Rise or Fall on Week.	Transactions. Lowest and Highest Prices During the Week.
1,551,868	Stk.	Oct. 9	7	7	Alliance & Dublin Ord. ...	130—140	+2½	136⅜–136⅞
374,000	„	Jan. 8	4	4	Do. 4 p.c Deb. ...	99—100	...	...
557,655	„	Mar. 5	7	7	Barnet Ord 7 p.c.	165—170*	...	167½
300,000	1	Oct. 23	1/9⅜	1/4⅛	Bombay, Ltd.	27/—29/-	...	...
178,480	Stk.	Feb. 19	9½	9½	Bournemouth sliding scale	197—207	+2	202—207
550,050	„	„	7	7	Do. 7 p.c. max. ...	162—167	+1	164—164¼
439,160	„	„	6	6	Do. 6 p.c. Pref ...	140—145	+1½	141⅞–145
50,000	„	Dec. 18	3	3	Do. 3 p.c. Deb. ...	75—80	...	...
262,025	„	„	4	4	Do. 4 p.c. Deb. ...	100—105	...	...
335,000	„	„	5	5	Do. 5 p.c. Deb. ...	120—125	...	...
357,900	„	Mar. 5	7½	7½	Brighton, &c., 6 p.c. Con. ...	161—166*	...	...
540,000	„	„	6¾	6¾	Do. 5 p.c. Con. ...	149—154*	...	151½–153
195,500	„	„	6	6	Do. 6 p.c. B. Pref.	135—140*	+1	...
1,487,500	„	Mar. 5	5	5	Bristol 5 p.c. max.	115—116a*	...	...
120,420	„	Dec. 18	4	4	Do. 1st 4 p.c. Deb. ...	101—103a	+1	...
217,870	„	„	4	4	Do. 2nd 4 p.c. Deb. ...	101—103a	+1	...
328,790	„	„	5	5	Do. 5 p.c. Deb.	120—123a	...	...
885,000	„	Sept. 25	8	7	British Ord.	155—160	...	...
100,000	„	Dec. 18	7	7	Do. 7 p.c. Pref.	153—158	...	157½
350,000	„	„	5½	6½	Do. 5½ p.c. Pref.	106—111	...	...
120,000	„	„	4	4	Do. 4 p.c. Red. Deb. ...	95—100	...	...
450,000	„	„	5	5	Do. 5 p.c. Red. Deb. ...	107—112	...	...
160,000	„	Jan. 8	5	5	Cambridge 5 p.c. Deb. ...	115—120	...	...
100,000	10	May 22	6	4	Cape Town, Ltd.	5—6	...	...
100,000	10	Nov. 6	4½	4½	Do. 4½ p.c. Pref. ...	6⅞–7⅞	...	...
150,000	Stk.	Dec. 18	4½	4½	Do. 4½ p.c. Deb. ...	95—100	...	...
626,860	„	Feb. 19	6	6	Cardiff Con. Ord.	125—130	+4	...
237,860	„	Jan. 8	5	5	Do. 5 p.c. Red. Deb.	103—108	...	...
157,150	„	Feb. 19	5	6½	Chester 5 p.c. Ord.	112½–129½b	...	...
98,936	1	Oct. 9	2/-	2/-	Colombo, Ltd. Ord.	1⅝–1⅞	...	...
24,500	1	„	1/4⅛	1/4⅛	Do. 7 p.c. Pref. ...	19/- –21/-	...	...
609,204	1	Oct. 9	/11'48	/11'48	Colonial Gas Assn. Ltd. Ord.	1⅛–1⅛	...	...
296,053	1	„	1/8'80	1/8'80	Do. 8 p.c. Pref.	25/—26/-	...	...
1,775,005	Stk.	Feb. 19	5	6½	Commercial Ord.	120—126	...	121 122½
475,000	„	Dec. 18	3	3	Do. 3 p.c. Deb. ...	76—81	...	...
283,344	„	Mar. 5	5	5	Do. 5 p.c. Deb. ...	119—124*	...	...
807,560	„	Feb. 19	7	7	Croydon sliding scale ...	151—156	...	154—156
569,590	„	„	5	5	Do. max. div.	103—108	...	...
620,385	„	Jan. 8	5	5	Do. 5 p.c. Deb.... ...	120—125¶	...	...
542,270	„	Mar. 5	7	10	Derby Con.	175—180c*	...	...
55,000	„	Jan. 8	4	4	Do. 4 p.c. Deb.	98—100c	...	...
209,000	„	Feb. 19	5	5	East Hull Ord. 5 p.c. ...	106—111	...	107
181,625	„	Mar. 5	6	6	East Surrey Ord. 5 p.c. ...	126—131*	...	128¼
175,809	„	Dec. 18	5	5	Do. 5 p.c. Deb. ...	115—120	...	...
1,002,180	„	Sept 25	†7	†5	European, Ltd.	125—135	...	125
19,342,763	„	Feb. 19	5⅜	5⅜	Gas Light & Coke 4 p.c. Ord.	25/6—26/6f	...	25/7½—26/1½
3,600,000	„	„	3½	3½	Do. 3½ p.c. max.	87—90	+1	87—88½
4,477,106	„	„	4	4	Do. 4 p.c. Con. Pref. ...	102—105	...	104—105
6,102,497	„	Dec. 18	3	3	Do. 3 p.c. Con. Deb. ...	83—86	...	84½—85½
3,642,770	„	„	5	5	Do. 5 p.c. Red. Deb. ...	115—118	...	117½
3,500,000	„	„	4½	4½	Do. 4½ p.c. Red. Deb. ...	113—116	...	114—115¾
270,466	„	Mar. 5	6	6	Harrogate New Cons. ...	125—130*	...	...
82,500	„	Mar. 5	7	7	Hastings & St. L. 5 p.c. Conv.	147—152*	...	...
258,740	„	„	5½	5½	Do. 3½ p.c. Conv.	115—120*	...	...
140,000	1	Oct. 9	110	1/7⅛	Hongkong & China, Ltd. ...	29/— 32/	...	...
213,200	Stk.	Mar. 5	6	6	Hornsey Con. 3½ p.c. ...	128—135*	...	...
5,600,000	„	Nov. 6	14	10	Imperial Continental Cap.	204—209	...	204—207
223,130	„	Feb. 5	3½	3½	Do. 3½ p.c. Red. Deb.	89—94	...	...
235,242	„	Mar. 5	8½	8½	Lea Bridge 5 p.c. Ord. ...	169—174*	...	170½
2,167,410	„	Mar. 5	6	6	Liverpool 5 p.c. Ord ...	129½–131½*	...	...
245,500	„	Dec. 18	5	5	Do 5 p.c. Red. Pref. ...	101—111*	...	...
306,083	„	July 17	4	4	Do. 4 p.c. Deb. ...	101½–103½	...	...
165,736	„	Feb. 19	8	10	Maidstone 5 p.c. Cap. ...	180—190	...	...
56,176	„	Jan. 8	3	3	Do. 3 p.c. Deb. ...	72—77	...	...
75,000	5	Dec. 4	†10	†10	Malta & Mediterranean ...	9—11	...	10½
392,000	—	Oct. 2	5½	5½	Metropolitan (of Melbourne) 5½ p.c. Red. Deb.	98—103	...	...
231,978	Stk.	Feb. 19	5	5	M. S. Utility "C." Cons. ...	113—118	...	...
818,657	„	„	4	4	Do. 4 p.c. Cons. Pref.	95—100	...	98—99
360,075	„	Jan. 8	4	4	Do. 4 p.c. Deb. ...	100—105	...	...
148,955	„	„	5	15	Do. 5 p.c. Deb. ...	117—122	...	...
675,000	„	21 May '31	16	6	Montevideo, Ltd.	60 -70	...	62—64
2,961,315	„	Mar. 5	5	5½	Newcastle & Gateshead Con.	25/6–26/-d*	...	...
682,856	„	„	4	4	Do. 4 p.c. Pref. ...	99—100d*	...	...
776,706	„	Jan. 8	3½	3½	Do. 3½ p.c. Deb. ...	90½–91½d	...	...
277,285	„	Nov. 6	5	5	Do. 5 p.c. Deb. '43 ...	106—107d	...	...
274,000	„	Feb. 19	5	5	Newport (Mon.) 5 p.c. max.	102—104a	...	...
204,940	„	Aug. 28	7½	7½	North Middlesex 6 p.c. Con.	157—162	...	...
396,160	„	Feb. 5	5	5	Northampton 5 p.c. max. ...	99—104	...	...
300,000	„	Dec. 4	7	†9	Oriental, Ltd.	147—152	...	...
316,617	„	Dec. 18	8	8	Plym'th & Stonehouse 5 p.c.	165—170	...	...
504,416	„	Feb. 19	8	8	Portsm'th Con. Stk. 4 p.c. Std	168—173	...	170—172
241,446	„	„	5	5	Do. 5 p.c. max. ...	105—110	...	107
114,000	„	Feb. 19	5	5	Preston 5 p.c. Pref.	103—108	...	...
686,312	„	Jan. 22	4	4	Primitiva 4 p.c. Rd. Db. 1911	87—92	...	90
389,813	„	Dec. 18	4	4	Do. 4 p.c. Cons. Deb.	98—93	...	...
150,000	10	Sept. 25	6	6	San Paulo 6 p.c. Pref. ...	6¾–7¾	...	...
1,736,968	Stk.	Sept. 11	6	6	Sheffield Cons	135—137e	...	...
95,000	„	Jan. 8	4	4	Do. 4 p.c. Deb.	94—98e	...	...
133,201	„	Feb. 19	8½	5	Shrewsbury 5 p.c. Ord. ...	135—140	...	...
90,000	10	June 12	15	14	South African	3—5	...	3½
6,709,895	Stk.	Feb. 19	5	7	South Met. Ord.	131—131	...	131½–133¼
1,135,812	„	„	6	6	Do. 6 p.c. Irred. Pf.	138—143	...	140
850,000	„	„	4	4	Do. 4 p.c. Irred. Pf.	101—105	...	101¾–105
1,895,445	„	Jan. 8	3	3	Do. 3 p.c. Deb. ...	82—85	...	84½–85
1 000,000	„	Jan. 22	5	5	Do. 5 p.c. Red. Deb.	111—115	...	...
209,820	„	Mar. 5	8½	8½	South Shields Con.	166—167e*	...	...
1,543,795	„	Feb. 19	6	6	South Suburban Ord. 5 p.c.	129—134	...	131—133½
512,825	„	„	5	5	Do. 5 p.c. Pref.	114—119	+2	117
300,000	„	„	—	4	Do. 4 p.c. Pref.	99—102	...	...
868,837	„	Dec. 18	5	5	Do. 5 p.c. Deb.	120—125	...	...
100,000	„	„	4	4	Do. 4 p.c. Deb.	100—103	...	...
647,740	„	Mar. 5	5	5	Southampt'n Ord. 5 p.c. max.	109—114*	...	111—112
121,275	„	Dec. 18	4	4	Do. 4 p.c. Deb.	97—102	...	...
350,000	„	Mar. 5	5½	5½	Swansea 5½ p.c. Red. Pref.	106 - 111*	...	...
200,000	„	Dec. 18	6½	6½	Do. 6½ p.c. Red. Deb.	103—108	...	...
1,076,490	„	Mar. 5	6½	6½	Tottenham and District Ord.	148—152*	...	151—152
109,835	„	„	5½	5½	Do. 5½ p.c. Pref. ...	123—128*	...	...
62,235	„	„	5	5	Do. 5 p.c. Pref. ...	110—115*	...	113½
199,005	„	Dec. 18	4	4	Do. 4 p.c. Deb. ...	97—102	...	...
85,701	„	Oct. 9	6	6	Tuscan, Ltd. 6 p.c. Red. Db.	90—100	...	...
349,110	„	Mar. 5	7	7	Uxbridge, &c., 5 p.c. ...	147—152*	...	...
88,330	„	„	5	5	Do. 5 p.c. Pref. ...	110—115*	...	...
1,322,220	„	Mar. 5	7	7	Wandsworth Consolidated	155—160*	...	ex 155½–156½
1,096,373	„	„	5	5	Do. 5 p.c. Pref.	117—122*	...	119½
1,317,964	„	Dec. 18	5	5	Do. 5 p.c. Deb.	120—125	...	123
158,400	„	Mar. 5	5	6a	Winchester W. & G. 5 p.c. Con.	115—120*	...	...

Quotations at:—*a.*—Bristol. *b.*—Liverpool. *c.*—Nottingham. *d.*—Newcastle. *e.*—Sheffield. *f.*—The quotation is per £1 of stock. *g.*—Paid £3, including 10s. on account of back dividends. * Ex. div. † Paid free of income-tax. ‡ For year. Hongkong & China, Ltd.—paid on £10 shares.



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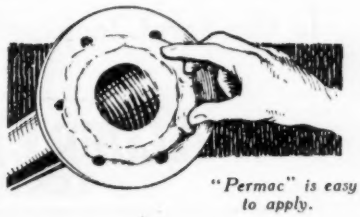

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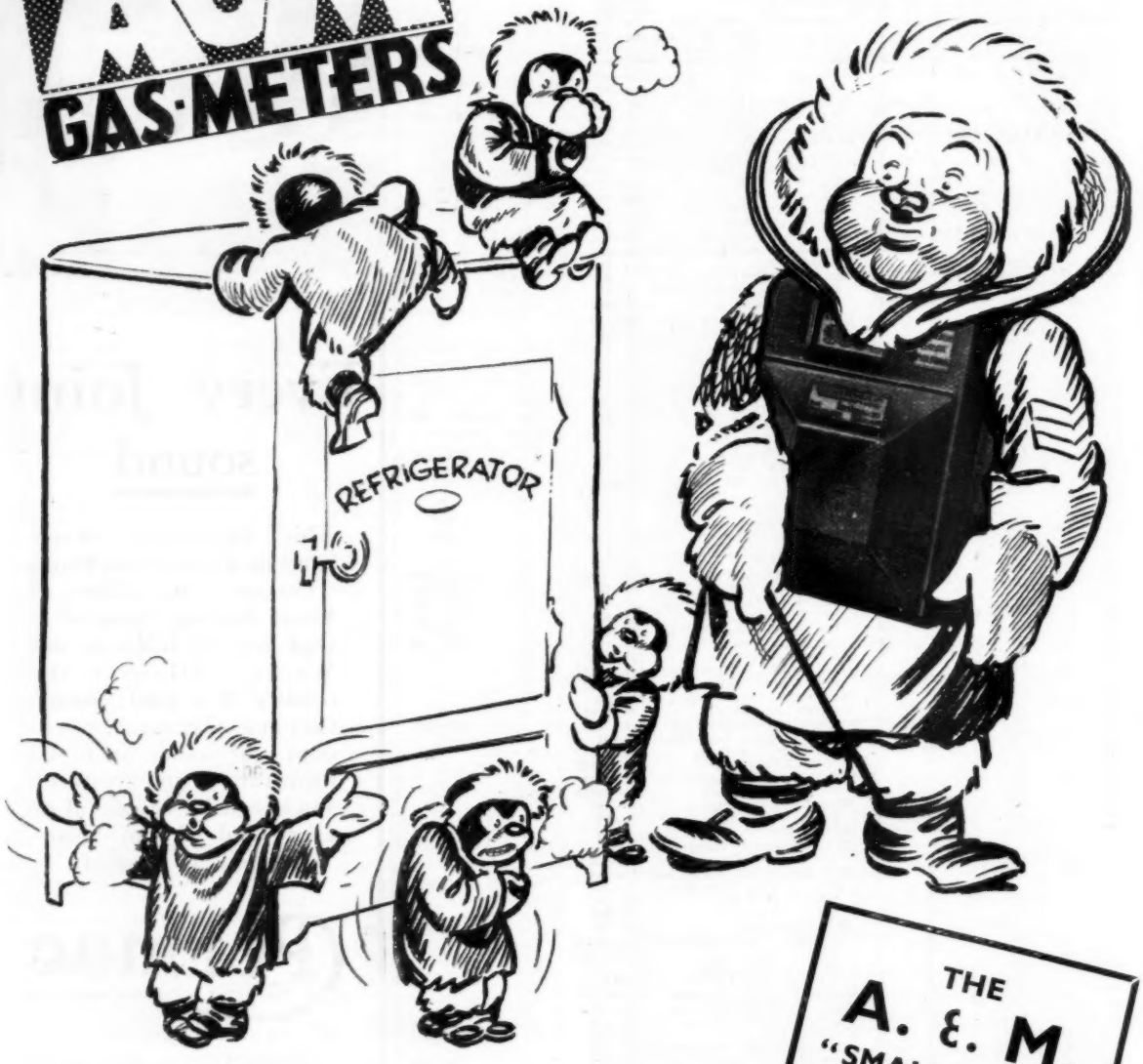

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